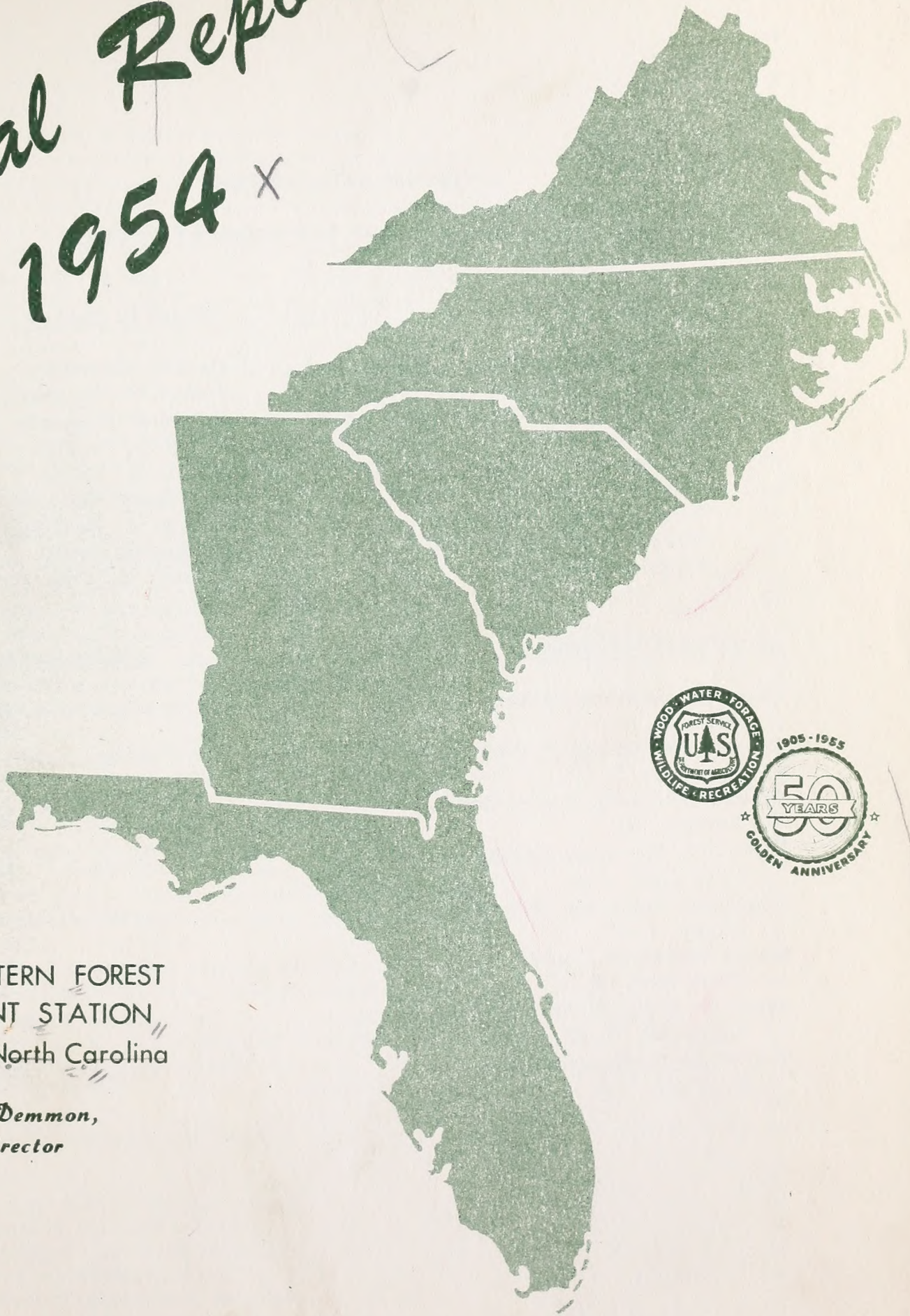
tion Paper No. 50 February 1955

Annual Report, 1954



SOUTHEASTERN FOREST
EXPERIMENT STATION
Asheville, North Carolina

E. L. Demmon,
Director

U. S. Department of Agriculture - Forest Service

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SOUTHEASTERN FOREST EXPERIMENT STATION

INTRODUCTION

With the increase in all forms of forestry activity in the Southeast has come an expansion in some of the Station's research work and facilities. In 1954, Congress provided additional funds for hardwood utilization and management research in this area. In view of the increasing volume and area in hardwoods throughout the Southeast, the Station plans to develop useful facts on soil and site requirements for optimum growth of Piedmont hardwoods. Regeneration and management of good Piedmont hardwoods and the rehabilitation of poorer stands will also be studied. The long-continued efforts to find profitable industrial uses for the little-used and defective Piedmont hardwoods are being stepped up. Out of the combined efforts should come a reduction in the accelerating volume of low-grade hardwoods, and an increase in the better-quality hardwoods the Piedmont is capable of growing. This new work is being centered at the Athens-Macon Research Center, with headquarters at Athens, Georgia, where the Station is working closely with the School of Forestry, University of Georgia. Federal-State cooperation is also working very effectively at the new Georgia Forestry Center at Macon, where the Georgia Forestry Commission, the Georgia Forest Research Council, and the Station are cooperating in an expanded program of forest research.

Very rapid progress has been made in research in tree genetics and other forestry fields in Florida, where the State Board of Forestry participated through a grant from the Florida legislature. In South Carolina, solution of problems in Sandhill regeneration was speeded up by joint action of the Station and the South Carolina Forestry Commission.

A major Station responsibility is to gage the forest situation in its territory periodically and point out far-reaching trends, such as the recent reversion of large areas from pine to hardwoods. Thorough-going surveys made periodically by the Station's Forest Survey staff provide the best picture available. The Station has recently summarized the changing forest situation in the three southeastern states, Florida, Georgia, and South Carolina. The period covered is that between the original forest surveys of 1934-36 and the resurveys made approximately 15 years later.

The actual commercial forest area in these 3 states increased about 6 percent between surveys, due largely to abandonment of farmlands.

Wood use increased greatly; the major increase was for pulpwood, with production rising from 350,000 cords in 1936 to 6 million cords in 1953. The equivalent rise in terms of proportion of total drain was from 3 to 35 percent.

Whereas the total volume of both pine and hardwoods decreased about 3 to 4 percent between surveys, the situation in some local areas showed much larger decreases than this, and there were also a few increases.

The character of the forest changed considerably between surveys, the number of smaller trees increasing and the number of larger trees decreasing. Also of great significance is the increase in area of hardwood types (areas with less than 25 percent pine volume) from 12.2 million acres to 19.3, or 58 percent.

Net growth of both pine and hardwood showed an increase at the time of the resurvey, largely due to reduction in mortality, and to the great improvement in stocking of young, fast-growing trees. Even though growth increased from an average of 0.30 to 0.44 cords per acre, there is opportunity for southeastern forest landowners to nearly double this current growth by the wide adoption of better forestry practices.

These resurvey results bring out several challenges to research. Perhaps the most important problem is the loss of pine area to hardwoods. We need to intensify our research on techniques of regenerating pine, both naturally and artificially. The tremendous current planting program also means that we can apply the results of tree improvement research just as soon as they are available.

If we are to increase our forest growth, we will need better information about the relative productivity of the same land for different species and since we have so much more hardwood area today than we had a few years ago, we need to accelerate research on the utilization and management of these species.

E. L. Demmon

Director

FOREST MANAGEMENT

REGENERATION

As in previous years, a portion of the effort at each research center of the Station has been directed toward finding better means of obtaining satisfactory stocking of desirable forest trees through natural restocking, direct seeding, or planting. These studies range in site from the overly wet areas of south Florida and the Coastal Plain through the dry, sandy stretches of the Sandhills. Pine regeneration has been emphasized to keep pace with the ever-expanding demand for southern pine timber and fiber, and the steady regional decline in acreage of land that is growing pine. At the same time, the need for much better information on hardwoods, both bottomland and upland, has been recognized by including them in the regeneration studies.

Stimulation of Slash Pine Seed Production

The beneficial effect of crown release upon seed production 3 years after release was demonstrated in slash pine at Tifton, Ga., as it had previously been in loblolly pine elsewhere. This stimulation of the seed crop is carried over into at least the fourth year (fig. 1). Studies have been started of the seed production of shortleaf pine in the Piedmont region, in cooperation with Clemson College and the Duke Power Company.

Favorable Seedbed Conditions Deteriorate Rapidly

Past work in the Coastal Plain of the Carolinas has shown that timely site preparation is necessary to successfully reproduce loblolly pine. In the second growing season after logging, the seedbed is occupied by competing vegetation to such an extent that it requires three to five times as much seed to produce a pine seedling as in the first growing season after logging. By the end of the third growing season the deterioration of the natural seedbed made effective seeding improbable, as shown in table 1.

Table 1.--Number of sound seed to produce an additional seedling at the end of the growing season by seedbed treatments of entire logging units, 1/ Bigwoods Experimental Forest

Cultural practice	1st year	2nd year	3rd year	4th year	4th and 5th year
	Number	Number	Number	Number	Number
Disk and log	7	37	187	--	--
Log and burn	15	69	211	--	200
Log only	22	63	81	143	227
Average all areas	14	50	162	143	212

1/ The data in each vertical column are averages which sample one to fourteen different areas.

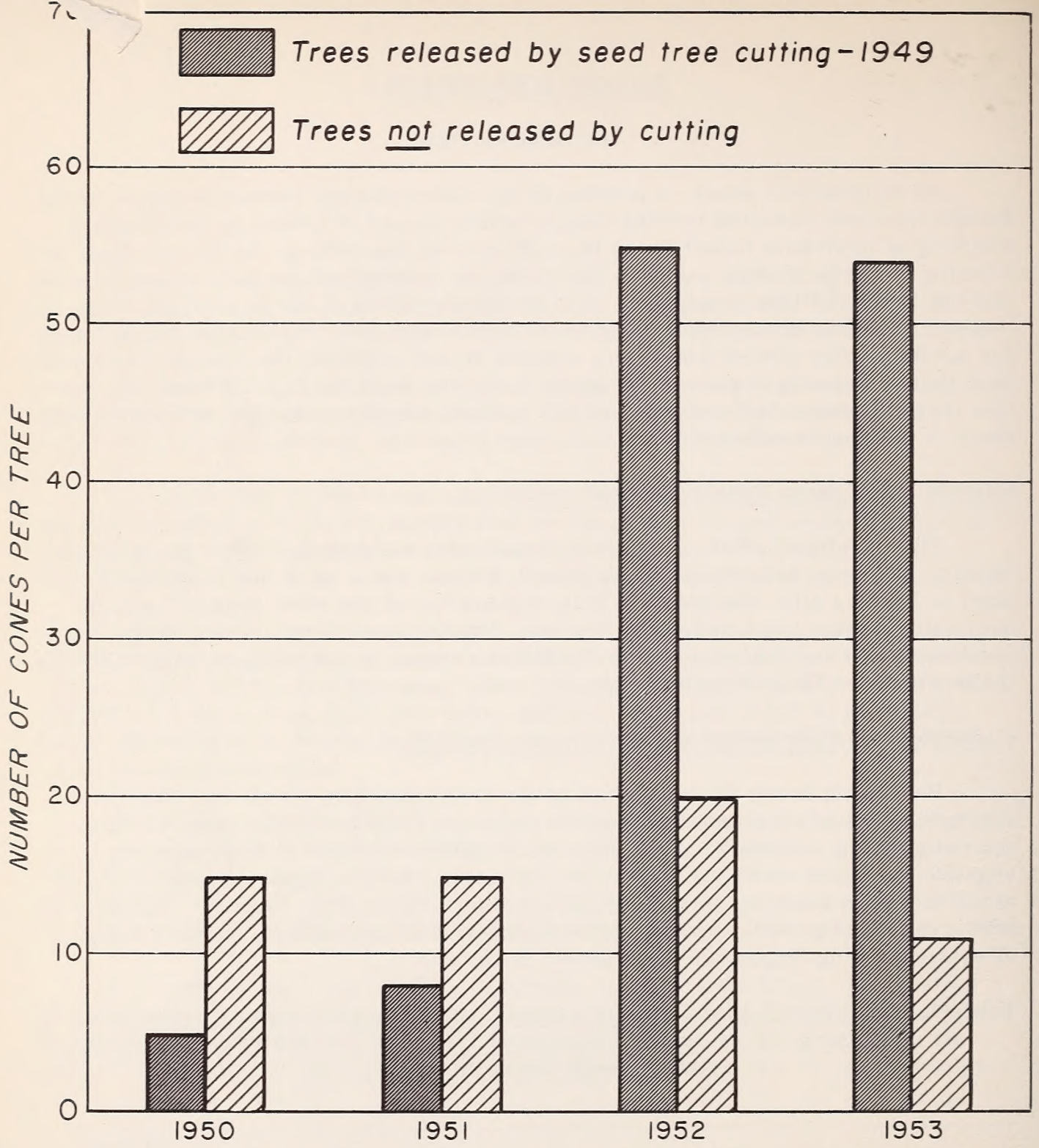

Figure 1.--Slash pine cone production is increased the third year after seed trees are released. Data from Alapaha Experimental Range near Tifton, Georgia.

Rodent Population Peaks Soon After Clear Cutting

A study in the North Carolina Coastal Plain showed that the population of seed-eating rodents and shrews was normally low in mature, uncut stands. Figure 2 shows that in successive years after harvest cutting, the number of seeds required to establish one pine seedling steadily increases, while the population of small mammals peaks during the first growing season and then gradually declines. The divergence of the two trends indicates that factors other than mammal population are involved in the successively poorer utilization of pine seed. These factors probably are the increased amount of litter on the seedbed and increased competition from hardwood sprouts and other vegetation.

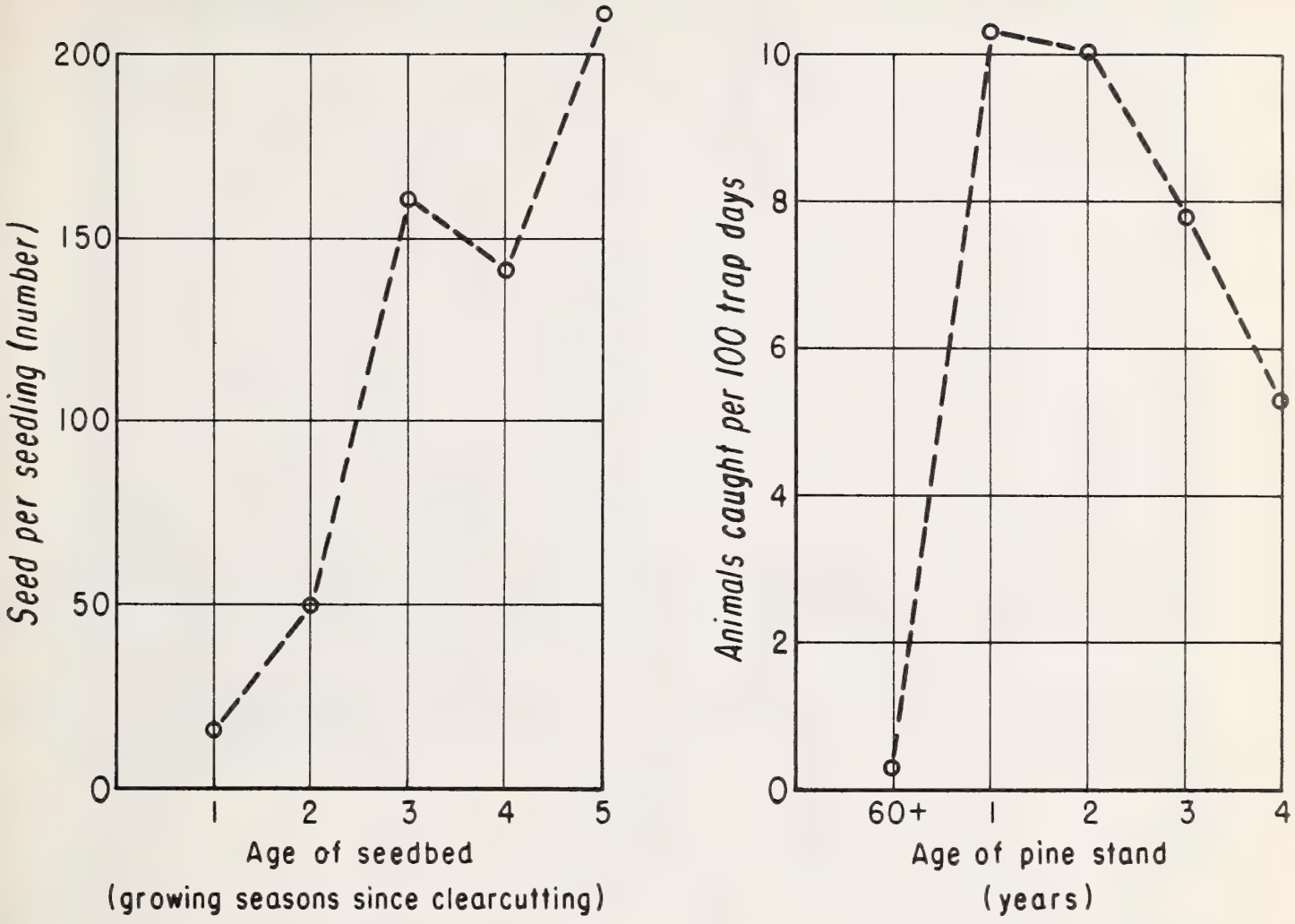

Figure 2.--Trends of seedbed deterioration and rodent population for comparable periods, Bigwoods Experimental Forest, North Carolina.

Scarification Before Logging Improves Pine Stocking

An analysis of regeneration records on four 40-acre compartments on the Bigwoods Experimental Forest in eastern North Carolina shows the benefits of scarification with a tractor-drawn disk and drag before clear cutting of mature loblolly pine with a hardwood understory. In the new stand, at 5 to 6 years of age, the basal area of al' stems 1 inch and over shows the hardwood component to be $3\frac{1}{2}$ times greater than pine on compartments which were untreated, whereas on compartments which had been disked before logging the pine basal area is more than twice the hardwood basal area. This contrast will become more convincing with time because on the untreated area the majority of the pine stems are subject to hardwood competition, whereas on the disked area a substantial proportion of pine is free of competition. Near the Santee Experimental Forest in the South Carolina Coastal Plain similar results were obtained when a tractor-drawn disk was used before logging to prepare the seedbed. Figures 3, 4, and 5 illustrate this comparison on one area.

Figure 3.--Mature stand of loblolly pine-hardwoods on the Francis Marion National Forest in Coastal Plain of South Carolina.

Figure 4.--Same area as figure 3, four years after logging, showing scattered pine reproduction in heavy hardwood competition. Larger hardwoods were poisoned after the first growing season at cost of $2.08 per acre.

Figure 5.--Same general area as figure 3 and figure 4, photographed 4 years after logging. Seedbed scarified with tractor-drawn disk harrow before logging, and large hardwoods poisoned. Total cost of scarification and poisoning was $5.73 per acre.

Time of Cut Important in Sand Pine

In a 4-year study of sand pine regeneration on the Ocala National Forest in Florida, it was established that clear cutting of mature stands from August to December will normally result in satisfactory regeneration of young seedlings because the seeds will become established during the period when they are least likely to be killed by high surface temperature. Detailed studies have shown that heat injury is a major cause of seedling mortality in sand pine.

Drained Cypress Ponds Reproduce to Slash Pine

Draining waterlogged areas such as the cypress ponds of the flatwoods of south Georgia and north Florida produces an area capable of supporting slash pine. This was demonstrated by a cooperative study with the Soil Conservation Service and the Altama Plantation, near Brunswick, Ga. Figure 6 shows portions of the area before drainage in 1947, and 5 years later.

Figure 7 shows graphically the effect that distance from seed source has on natural restocking of the drained land. Satisfactory stocking (50 percent or more of the milacres stocked) occurred only in the first 100 feet from the seed source. Between 100 feet and 250 feet, stocking was adequate for low or medium intensity of management (20 to 50 percent). Beyond 250 feet from the seed source, stocking was unsatisfactory and planting would be required.

Figure 6.--Cypress pond. A, Before drainage was established; no slash pine reproduction is present. B, Five years after drainage, pine seedlings have invaded the drained land. Stocking was satisfactory up to 250 feet from an established seed source.

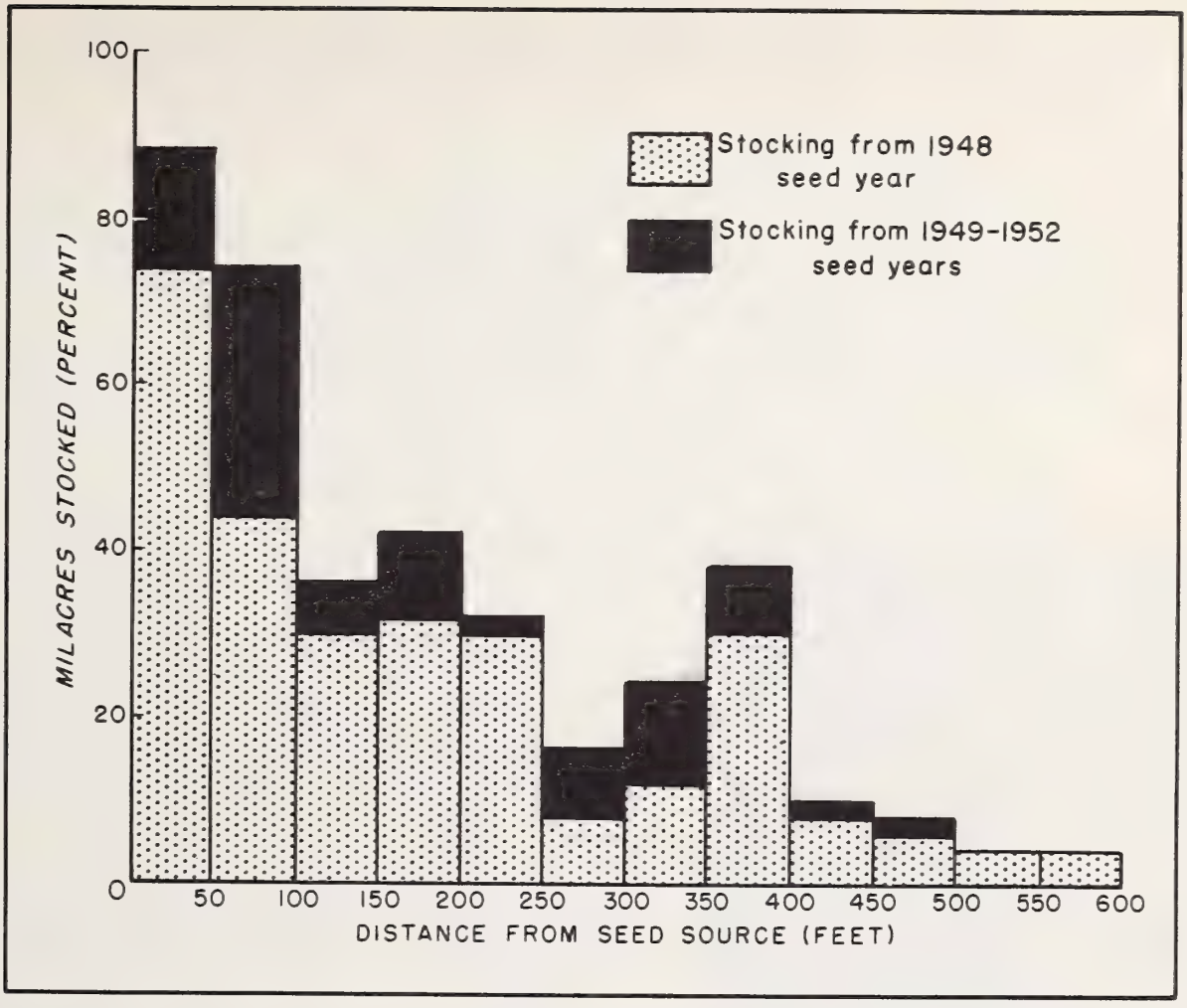

Figure 7.--Natural regeneration of slash pine in drained cypress pond near Brunswick, Ga.

Aids in Predicting Dominance for Pine Seedling

Forest managers constantly have to try to predict the ultimate dominance of young loblolly pine regeneration in competition with hardwoods. Seedling vigor of loblolly pine as reflected in subsequent height growth was found to be strongly correlated with height, number of branches, and the previous season's height growth. Coefficients of correlation were found to be

Previous season's growth	-	0.83
Number of branches	-	0.74
Height	-	0.79

Further investigations are being made to convert this type of information into a system for determining the need for silvicultural treatment of reproduction stands.

Cooperative Longleaf Pine Planting Study

Efforts to find satisfactory means of establishing forest stands on the Sandhills area of North and South Carolina are continuing, and additional studies have been established in cooperation with the South Carolina Commission of Forestry. These are designed to develop techniques leading to the successful regeneration of pine on the extensive areas of scrub oak in the Sandhills. This very dry year

has been a severe test for all the planting treatments, and the fact that first-year longleaf pine survival was best in furrows indicates the need for continuation of site preparation studies.

Direct Seeding Hampered by Rodents

In preliminary tests of direct seeding of longleaf pine in the Sandhills, carried out in cooperation with the Savannah River Project of the Atomic Energy Commission, one-third to one-half of the seed was lost to rodents even though the seedspots were protected by pinned-down wire screen cones (fig. 8). About 90 percent of the seed was lost to both rodents and birds when the spots were not protected.

Figure 8.--Only one longleaf pine seedling escaped rodent depredation on this Sandhill seedspot protected with pinned-down screen of hardware cloth. Note entrance to rodent burrow.

Bottomland Hardwoods Tested

A test of planted bottomland hardwoods is continuing in the South Carolina Coastal Plain. Initial survival of four hardwood and three conifer species was excellent, both on cleared sites and under a forest canopy (table 2).

Root Pruning Benefits South Florida Slash Pine Seedlings

Modification of nursery technique is one means of producing seedlings better able to survive outplanting. Recent research has reduced nursery losses through seed treatment, spraying, and fumigation to control rusts, nematodes, and damping off. There is evidence in south Florida that root pruning seedlings in place has resulted in an increase in the number and growth of new roots after planting in the field, and might increase survival.

Table 2.--Midsummer survival by species, site and cover for bottomland hardwoods planted winter of 1953-54 on the Santee Experimental Forest, S. C.

Species	First bottoms		Terraces	
	Cleared	Not cleared	Cleared	Not cleared
	Percent	Percent	Percent	Percent
Yellow-poplar	69	77	95	98
Shumard oak	98	99	99	99
Cherrybark oak	95	96	99	100
Sweetgum	97	95	99	99
Redcedar	21	31	23	40
Spruce pine	88	92	93	96
Loblolly pine	97	99	97	98
All planting stock	85	89	91	95
Cherrybark oak acorns	31	14	42	29
Shumard oak acorns	33	11	31	23

STAND IMPROVEMENT

Investigations on the elimination or control of understory hardwoods in loblolly pine stands continue to increase our ability to prescribe satisfactory methods to accomplish such control and thus regenerate the pine stand successfully.

Summer Burning For Hardwood Control Tested

Prescribed burning in summer is a promising experimental hardwood control measure being studied in the Coastal Plain. Results from studies in South Carolina show that best results are obtained from a few successive annual summer fires. This was purely on an experimental basis and is not generally recommended. Summer burning has been done on the Santee Experimental Forest on a plot-wise basis for 8 consecutive years, and a 30-acre pilot-plant has been treated successfully by prescribed burning for the dual purpose of controlling the hardwoods and preparing the seedbed for pine reproduction (fig. 9). A similar study has been installed on a series of 40-acre compartments on the Camp Experimental Forest in the Coastal Plain of Virginia. Any prescribed burning is a hazardous operation, and should be done only under competent supervision.

Understory Removal Does Not Affect Pine Growth

The effect of removal of the understory vegetation on the subsequent growth of a pine overstory was investigated in a 50-year-old, even-aged loblolly pine stand in South Carolina. A tally of the areas before treatment showed 10,434 shrubs and small hardwoods per acre below 7 inches in diameter in the understory.

Figure 9.--A, Stand of loblolly pine sawtimber on the Santee Experimental Forest in the Coastal Plain of South Carolina. B, Same area 6 years later, after two improvement cuts and four prescribed fires (one winter fire to reduce fuel, followed by three annual summer fires).

Growth of the overstory pines for a 5-year period was about the same on undisturbed control plots as on plots which received various understory treatments listed in table 3.

Table 3.--Overstory pine growth in 5 years as affected by understory hardwoods on the Santee Experimental Forest, S. C.

Understory treatment	Average d.b.h.	Radial growth	Basis
	Inches	Inches	Number of trees
Control	12.7	0.36	69
Annual foliage spray	12.7	0.37	61
Annual summer fire	12.6	0.35	73
Annual winter fire	12.3	0.38	68

Tests of Weeding to Free Pine Seedlings

Tests of weeding 3-year-old loblolly pine indicate that the most thorough release was obtained by cutting and spraying poisons on the cut stumps, but release by cutting alone was satisfactory at about half the cost (table 4). On this extremely brushy, high-site (105 ft.) area, the pine seedlings were able to keep ahead of the sprouts that resulted from cutting. On the other hand, in areas where the hardwoods and brush may give more serious competition to the pine seedlings, more effective and more expensive methods may be preferred.

Table 4.--The relative success of various weeding treatments after four growing seasons on the Santee Experimental Forest, S. C.

Treatment 1/	Relative cost 2/	Seedlings free to grow	Average total height 3/
	Index	Percent	Feet
Check, no treatment	0	22	4.9
Cut competing stems, no chemical	100	71	6.7
No cutting, basal spray with 2,4,5-T	124	80	7.2
No cutting, brush 2,4,5-T on stems	188	70	7.6
Cut competing stems and spray 2,4,5-T on stumps	194	97	8.8

1/ Each treatment replicated 3 times on 1/40th-acre plots.
2/ Includes labor and chemical charges, relative to cutting only.
3/ Based upon the best 75 seedlings for each treatment.

Management of Plantations Stressed

In recent years there has been a recognized need to expand the study of forest management systems by including clear cutting and planting as a system of management. This recognition has been intensified by the large areas of planted pines now reaching commercial size (fig. 10) as well as a trend, in some instances, toward small products and short rotations. As a result of a conference with industrial and other foresters, the compartment management plan on the Olustee Experimental Forest has been revised to include clear cutting and planting as one of the treatments under test. In Georgia, a plantation management study of slash pine including four rotations ranging from 19 to 50 years has been established, and after a harvest cut each area will be replanted. The schedule of thinning (T) and harvesting (H) in this study is shown in table 5.

Table 5.--Schedule of cutting

Rotation (Years)	Plantation age						
	19	25	30	35	40	45	50
19	H						
25	T	H					
35	T	T	T	H			
50	T	T	T	T	T	T	H

In south Florida, a study is under way involving 200, 400, 600, 800, 1000, and 1200 planted trees per acre, using both square and rectangular spacing.

Different Species Tested

The development of four species of southern pine will be followed on four important soil types in the flatwoods in north Florida. The first-year survival was low in this study owing to drought conditions, but it is interesting to note in table 6 that loblolly pine survival was uniformly higher than that of either slash or longleaf pine on all soil types, and sand pine made a good comparative showing on the drier sites.

Table 6.--Survival of comparison plantations--1 year

Soil	Topographic position	Survival				
		Slash	Loblolly	Longleaf	Sand	Mean
		Percent				
Blanton	Ridge	40	41	26	48	38.8
Leon (hardpan)	High flatwood	64	78	47	65	63.5
Leon (softpan)	Low flatwood	57	64	44	47	53.0
Plummer	Pond margin	78	88	69	45	70.0
Mean		59.8	67.8	46.5	51.2	56.3

Figure 10.--127-acre plantation near Cordele, Ga., at end of nineteenth growing season. The first thinning removed 6.14 cords per acre in trees worked 6 years for naval stores.

Study Plantation Thinning

A cooperative study involving methods of thinning plantations has been developed with the Georgia Forestry Commission. One hundred and twenty acres of planted slash pine at Milledgeville will be used to compare row thinning, selection thinning, diameter-limit thinning, and no thinning.

Reinforcement Planting Fails

A slash pine plantation that was originally planted 15x15 feet, and then a year later had a reinforcement planting to bring up the stocking, shows that a difference of only 1 year in age of planted trees can result in suppression of young trees (fig. 11). The spacing after the interplanting was $7\frac{1}{2}$x15. Measurements made 8 years after the reinforcement planting show the following difference in average size of the interplants and first plantings.

	Average d.b.h. (Inches)	Average height (Feet)
First planting	5.1	27.6
Interplants	2.6	19.1

Mortality was considerably higher among the interplanted trees, and the suppressed condition of the remaining trees indicates that the mortality rate of these reinforcement trees will continue to increase.

Figure 11.--At left and right are slash pine planted 15x15 feet at Cordele, Georgia. One year later they were reinforced with intervening trees such as the center row. These reinforcement trees have been so suppressed they will probably not pay the cost of planting.

MANAGEMENT OF PIEDMONT HARDWOODS

In view of the steadily increasing acreage of southern hardwoods and the shortage of information about these species, new funds were made available by the Congress in 1954 for research in the management and utilization of hardwoods in the Piedmont. The management studies will be under the Athens-Macon Research Center in Georgia and the Piedmont Research Center at Union, South Carolina.

The Athens-Macon Research Center is cooperating with the Forest Survey in preparation of a report on the status of the Piedmont hardwood resource. Personnel of the new hardwood management project at Athens are preparing a project analysis which will chart the course of the Station's future research in this field of work. Late in 1954 they also initiated studies of the growth rates and regeneration of different Piedmont hardwood species, in cooperation with the School of Forestry of the University of Georgia.

Arrangements are being made between the Southeastern Forest Experiment Station, the Furniture, Plywood, and Veneer Council of the North Carolina Forestry Association, and the Duke Power Company of Charlotte, North Carolina, for the establishment of an experimental forest for hardwood management research in Piedmont North Carolina. The Council will provide the services of a forester who will work half time on research, and the Duke Power Company will provide an experimental area. The Station will provide a full-time forester for research. The research will be under the guidance of a 12-man steering committee representing industry, forest schools, Duke Power Company, and the Station, and the direction of the work will be under the Leader of the Piedmont Research Center at Union, S. C. Personnel are being selected and the work will get under way early in 1955.

The Station will also initiate research at Union, South Carolina, on the soil requirements for growing different species of Piedmont hardwoods.

FARM WOODLAND MANAGEMENT

Returns to Farmer Operator Reported

Two formal reports on the operation of the farm woodland tracts on experimental forests were issued in the past year. An 8-year summary of the results of four woodlands in the Appalachians shows that if the timber is of average size and stocking a farmer or small woodland owner should be able to realize $3.00 per acre per year from the sale of stumpage alone. If he is able to cut and haul the products of the woodland, this per-acre amount can be increased fivefold. Ten years of operation of the Olustee farm woodland in Florida was reported in a circular issued jointly with the Agriculture Extension Service in Florida. The report shows that in spite of its initial rundown condition, the pine portion of the woodland has given an annual net return over 10 years of $2.51 per acre for stumpage plus an average of 79 cents per hour of labor after all costs are deducted. The next period of management of woodlands in both the mountains and the flatwoods should show even higher returns, as the improvement stage of management is over and the effects of the improvement operation will accrue.

Stocking Increased Under Management

On the Santee Experimental Forest a 5-year summary of farm woodland operations indicates a $4.82 per-acre per-year return for stumpage plus $1.02 per hour for labor and an estimated increase in stand per acre from 3300 to 3550 board-feet, as the annual harvest cuts have been less than the growth.

Naval Stores Income High

The naval stores operation of 553 working faces on the farm woodland of the George Walton Experimental Forest in Georgia continues to yield at a rate of over 300 barrels of gum per crop for the third successive year. This indicates a gross return of over 75 cents per face per year for the naval stores operation. The average diameter of the trees involved is over 14 inches, well above that of the average naval stores operation.

Growth Rate of Different Species on the Same Land

In deciding what species to plant on a given site or what species to favor in making improvement cuttings in mixed stands, we need much better information than we now have on the productivity of the same land for different species.

A step in this direction is the installation of soil-site studies in the mountains of North Carolina designed to correlate soil characteristics and site index for the various important forest species. Preliminary site index comparisons reflecting the height growth of different species on the same land have been made on the Bent Creek Experimental Forest. These comparisons are shown in figure 12. At age 50, white pine appears to be superior in height growth to all other species except yellow-poplar on the very best sites. Of species sampled, yellow-poplar is the most responsive to change in site.

Analyses are now being made of the particular soil and topographic features which may be useful in predicting the site index for each major species. Future studies will obtain this information for other species and other portions of the Appalachian mountain area.

Northern Red Oak Shows Sustained High Growth Rate

Growth studies on the Bent Creek Experimental Forest show northern red oak is outstanding among the Appalachian hardwood species in sustained diameter growth and quality increment in board-feet. Saw-log trees up to 36 inches in diameter, classed as high vigor on the basis of crown and bark characteristics, averaged 3.6 inches in diameter growth in 10 years.

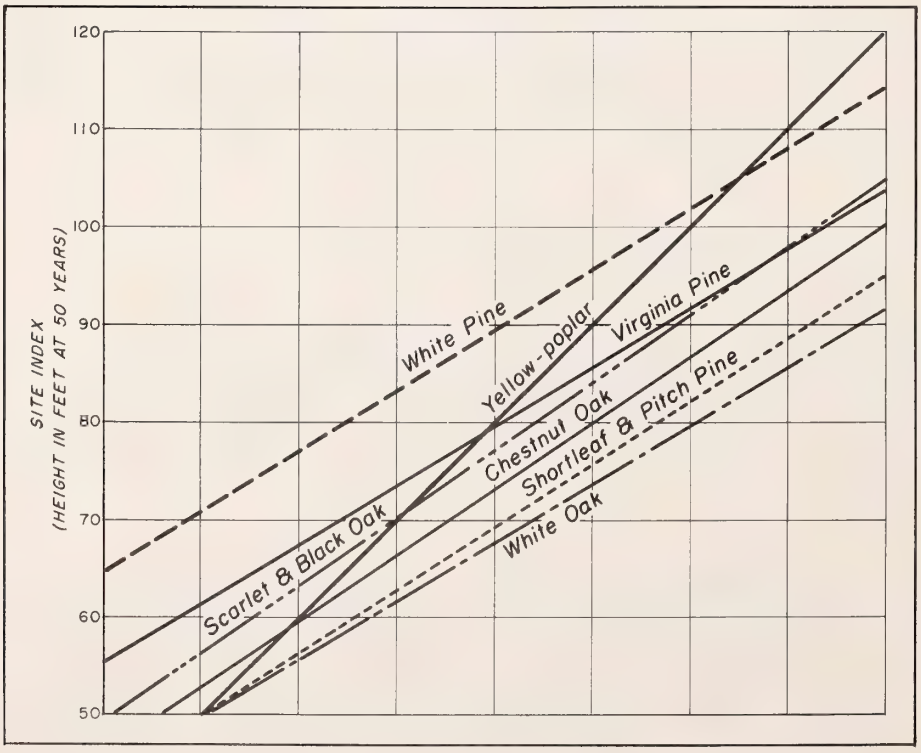

Figure 12.--Preliminary comparison of site indices for several different species on the same land in the Southern Appalachians. For example, for land that is site index 90 for white pine, read down and across to find that this same land may average site 80 for yellow-poplar and site 70 for shortleaf pine.

Forest Soil Studies

Two reports have been issued jointly with the Division of Watershed Management on the methods and equipment used for measuring the characteristics of forest soils. One report, Station Paper 38, covered the methods for determining soil moisture under field conditions, and the other, Station Paper 42, concerned sampling for pore space and percolation. Another joint study with the Division of Watershed Management reported the annual litter fall, weight of forest floor, and the incorporation of organic matter in the surface foot of mineral soil for pine, pine-hardwood, and hardwood stands in the South Carolina Piedmont (fig. 13). Organic matter in the mineral soil ranged from 25,780 pounds per acre under young loblolly pine to 83,550 pounds under old hardwoods, whereas the forest floor above the mineral soil contained 2 or 3 times as much material under pine as under hardwood. The more rapid decomposition under hardwoods is apparent. Separate determinations by 2-inch layers of soil showed the trends in nitrogen content parallel to those for organic matter.

Report on Nomenclature of Slash Pine

In 1953 the Station reported the change in name of slash pine from Pinus caribaea Morelet to Pinus elliottii Engelm., and the designation of South Florida slash pine as a separate variety (Pinus elliottii var. densa, Little and Dorman). During 1954 the Station issued a comprehensive 82-page report, Station Paper 36, "Slash Pine (Pinus Elliottii) Including South Florida Slash Pine," which gives in detail the botanical basis for the change in name and for the establishment of the new variety.

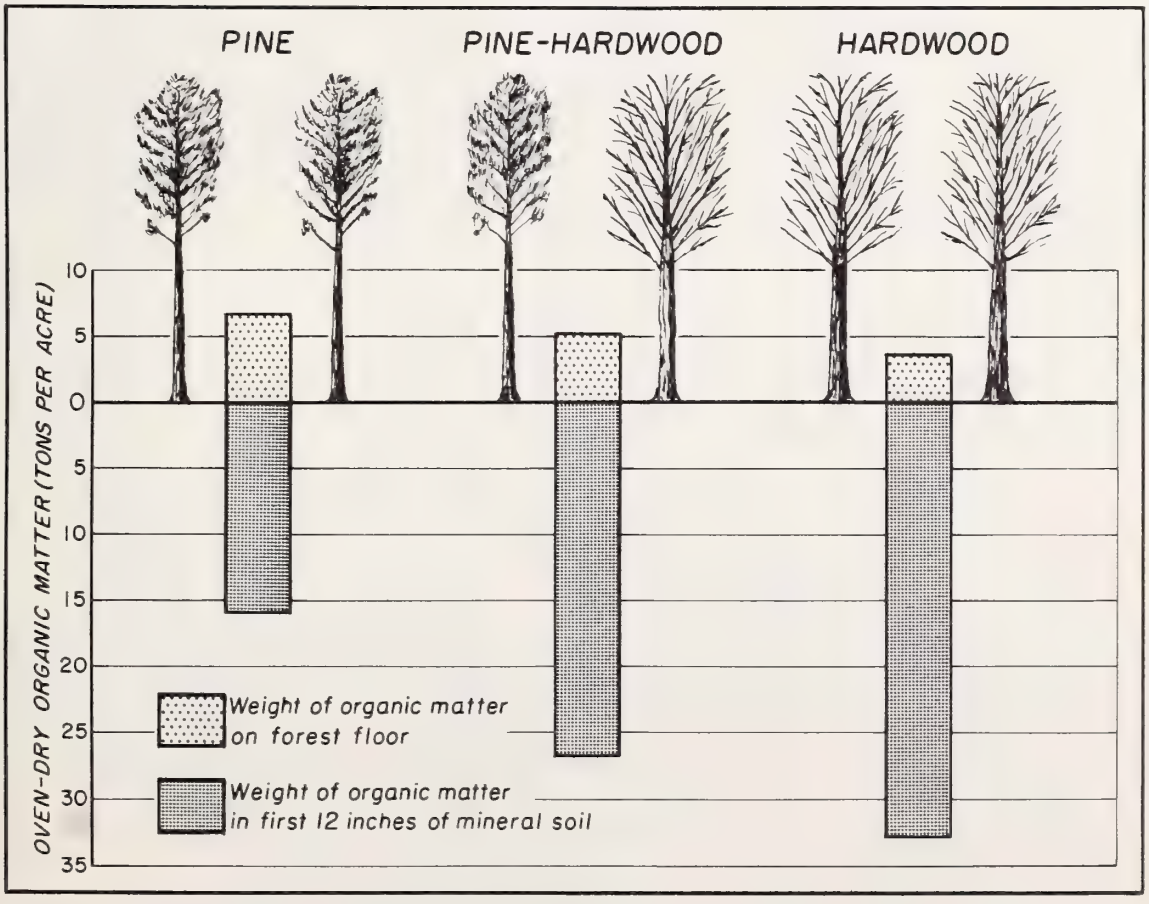

Figure 13.--Weight in tons per acre of organic matter under some Piedmont forest stands in South Carolina.

A survey of the research effort of the Station in the field of forest genetics discloses an impressive expansion during the past year. The increase has been greater in forest genetics than in any other field in which the Station operates. Much of this research is being conducted as a joint or cooperative effort with other agencies and organizations. Some phases are financed jointly by the Station and the Florida Board of Forestry. A similar joint financing agreement has been made with the Georgia Forest Research Council. These arrangements have made possible the erection of new greenhouse and laboratory facilities, as well as the employment of additional technical personnel.

Coordinated studies are in progress involving such agencies as the Schools of Forestry at the Universities of Georgia and Florida, the Georgia Forestry Commission, the Georgia Agricultural Experiment Station, the Ida Cason Callaway Foundation Tree Improvement Project at Hamilton, Ga., the Maria Moors Cabot Foundation of Harvard University, TVA, the Central States Forest Experiment Station, and the Committee on Southern Forest Tree Improvement. Many lumber and paper companies have cooperated by providing land and services to the various research centers.

Early Results Show Significant Trends

While genetics research is by nature a long-time undertaking and early conclusive results cannot be expected, there have been many significant findings and observations made in the past year. The Station has published in Station Paper 46, "How to Root and Graft Slash Pine," a graphic exposition of techniques tested at the Lake City Research Center for asexual propagation of pines (fig. 14). The perfection of air-layering techniques (see 1953 Annual Report) has enabled workers at Lake City to obtain a high percentage of success, in contrast to the low percentage which characterized initial attempts to root severed cuttings of slash pine. Other publications have explained the techniques of grafting very young seedlings upon stock of related species or even a different genus, and contain interim suggestions for seed orchard development.

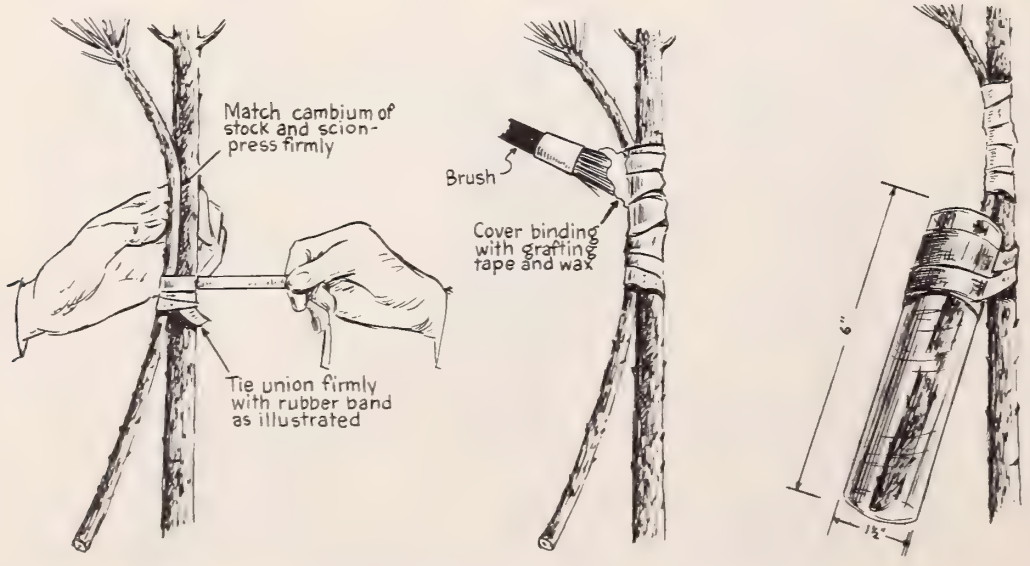

Figure 14.--Final steps in making a "bottle graft" on slash pine. This method can be used for grafting in the field and does not require a greenhouse or controlled environmental conditions.

Early observations on seed-source studies have shown racial differences that would be of interest to the practicing forester as well as the geneticist. In Florida, slash pine seedlings from Polk County seed were significantly shorter than those from four other geographic seed sources growing beside them (fig. 15). Polk County constitutes the southern limit of the natural range of typical slash pine and the northern range of South Florida slash pine. Other observations and comparisons indicate that Polk County seed may contain a relatively high percentage of "hybrids" between the two varieties of slash pine.

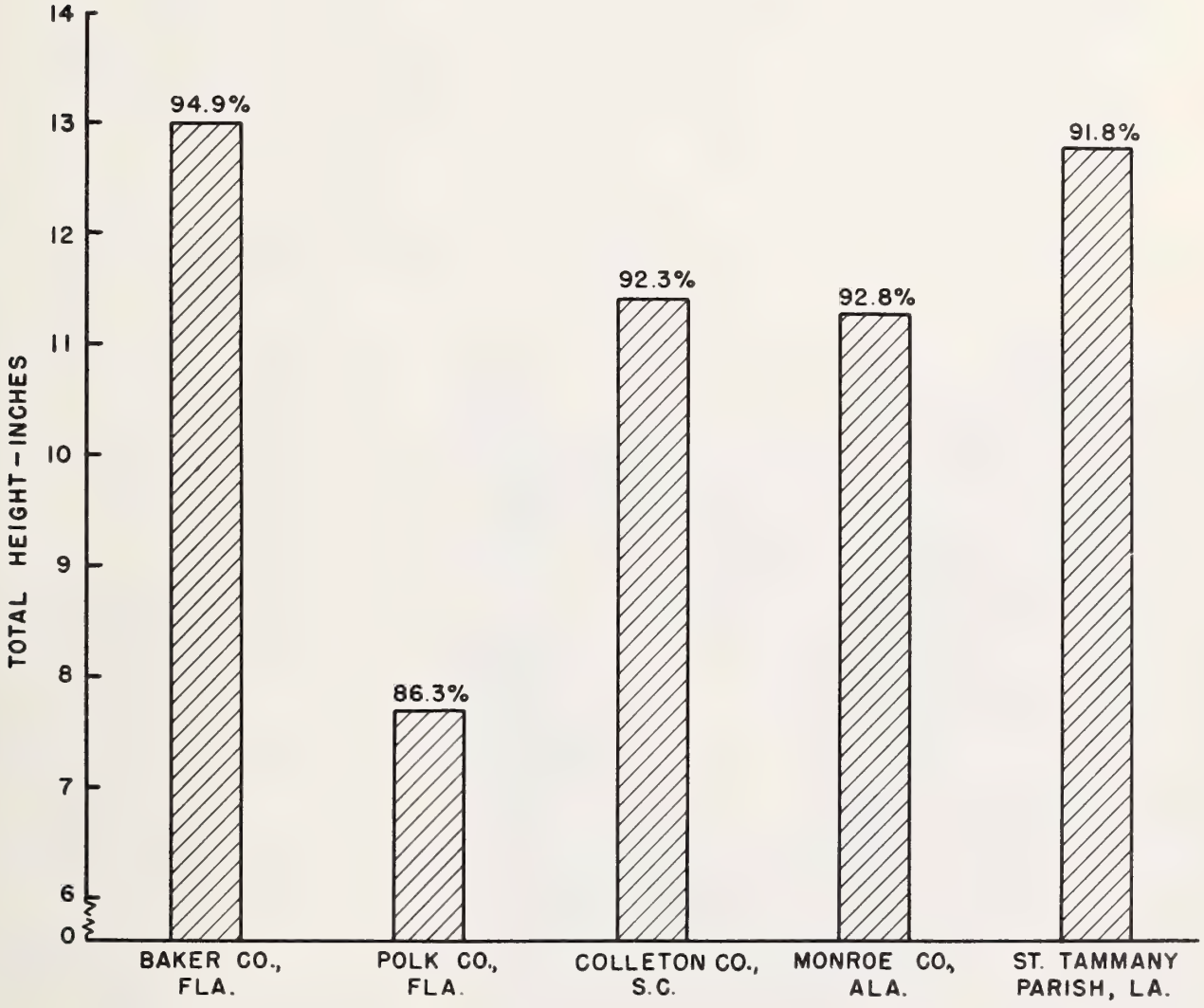

Figure 15.--Total height and survival of slash pine seedlings from five geographic sources outplanted in Baker County, Florida.

Records of infestations by a small bark beetle on scions of grafted slash pine demonstrate a definite relationship between the geographic origin of the scion and its susceptibility to attack by this insect. Fifth-year examination of a cooperative test of loblolly pine seed sources in South Carolina show differences in plantation survival, height growth, and susceptibility to Nantucket pine tip moth. At Bent Creek in North Carolina a test of six seed sources of red oak for the Maria Moors Cabot Foundation shows better survival from northern seed sources and better growth from southern ones at the end of 2 years. Seedling groups from various mother trees in Georgia varied widely in early vigor for

both slash and loblolly pine. Plots of a seed-source study of longleaf pine planted in southeastern Virginia had a high percentage of Sonderegger pine seedlings from the lot of seed collected locally at the northern limit of longleaf, although Sonderegger pines were supposedly culled at the nursery; only seedlings with no apparent height growth at 1 year were planted. One planted seedling was 1.5 feet tall at the end of the second year from seed.

Development of High-Yielding Naval Stores Pines

In an earlier study of the factors affecting gum flow, an equation was worked out estimating the relative yielding capacity of slash pine trees. This equation shows that flow rate of gum in a random sample of trees is proportional to the number of radial resin ducts per unit area multiplied by the average size of the ducts and divided by the viscosity of the gum. The next step was to determine which of these factors are inherited and to what extent.

In a progeny test of slash pine trees (fig. 16) it was demonstrated that gum yield is an inherited characteristic in slash pine. Progeny from outstanding

Figure 16.--Keith W. Dorman, who control-bred and planted the first seedlings for progeny testing of high-yielding turpentine pines, and Francois Mergen, who demonstrated the inherited nature of gum yield and viscosity, observe the fruits of their handiwork in a 9-year-old slash pine plantation.

phenotypes produced larger quantities of gum than did progeny of average trees (fig. 17). As was expected, not all of the selected high-yielding parents were capable of transmitting high yield to their progeny. Thus, progeny testing is essential before a selection is accepted for further breeding work.

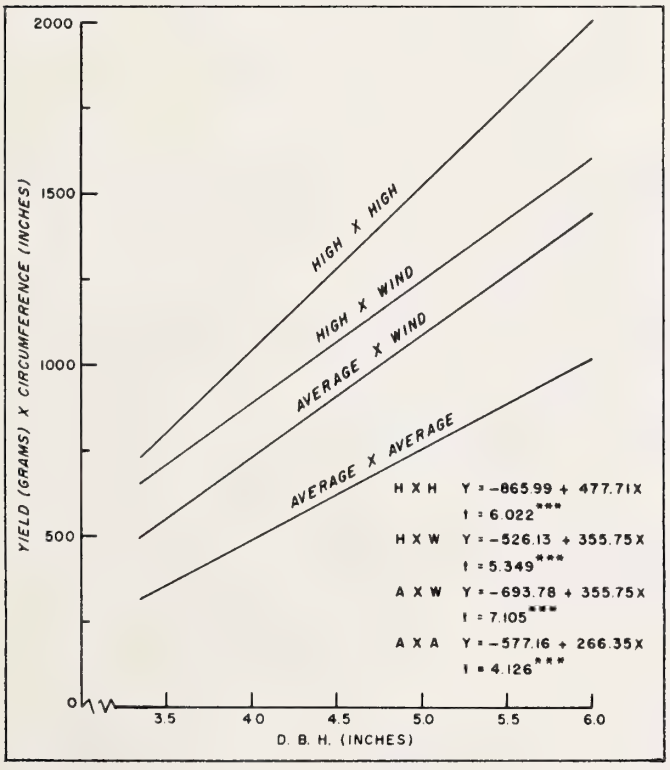

Figure 17.--Gum yields of progeny resulting from open pollination and from controlled pollination of high-yielding and average-yielding parent trees of slash pine. The results demonstrate that gum yield is an inherited trait in this species.

Results on the inheritance pattern of gum viscosity proved this trait to be under rigid genetic control. The effect of female parent and male parent on the progeny was clearly demonstrated (fig. 18).

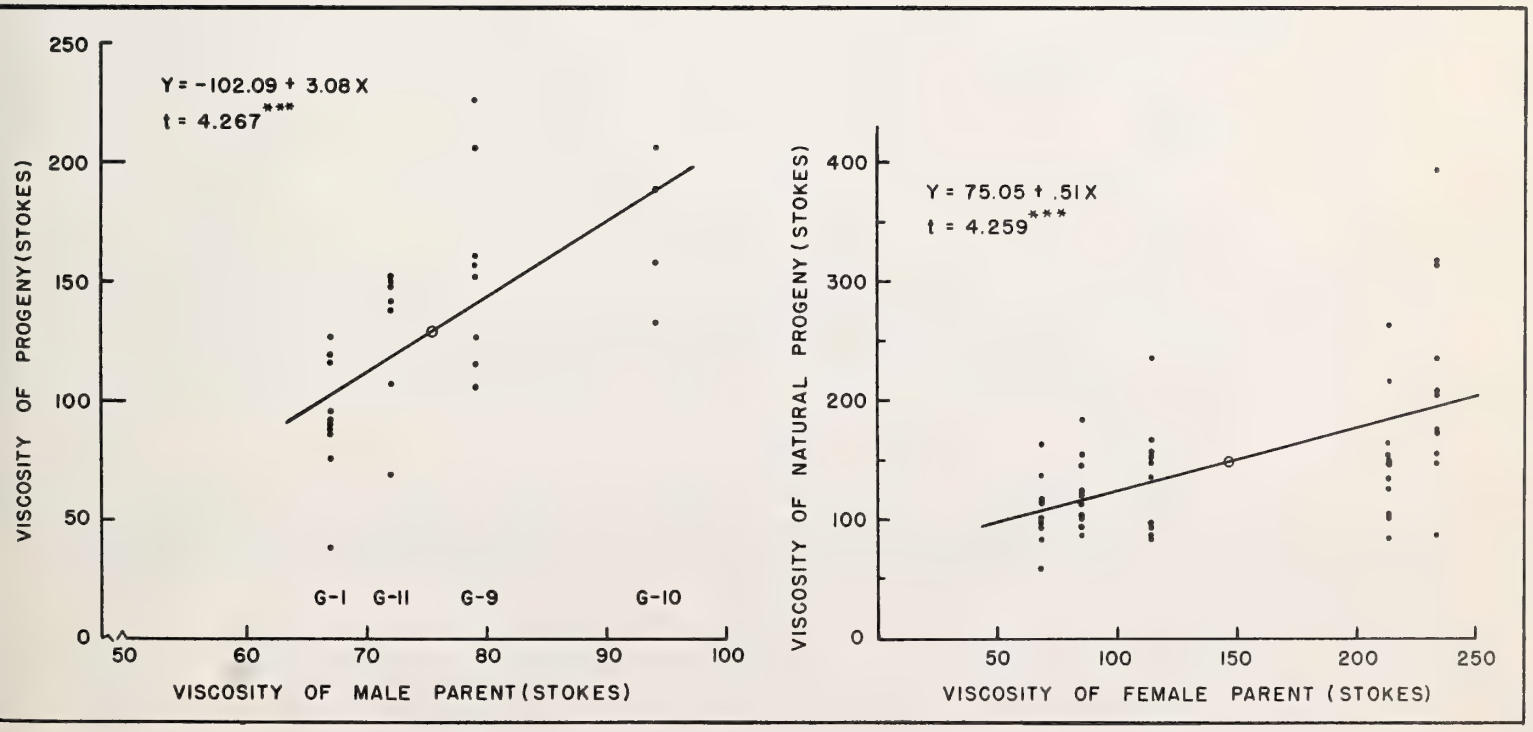

Figure 18.--Relationship between viscosity of gum from male and female parents with that of their progeny, demonstrating the inheritance of viscosity.

The number and size of radial resin ducts changed rapidly with an increase in age during the first 15 years in the life of the parents. This change probably accounts for the fact that no correlation was found between parents and their 9-year-old progeny with respect to these factors. These measurements will be repeated periodically during the life of the progeny to see whether the correlation improves when size and number of ducts approach constant values.

Scions from 11 tested high yielders were grafted on wildling stock for the purpose of establishing a 3-acre seed orchard on the Osceola National Forest.

Inheritance of Deformity and Growth in Slash Pine

Deformity of stem as evidenced by a crook in the lower portion of the bole was shown to be an inherited characteristic. When the deformed tree was used as either the male or female parent, over 65 percent of the progeny exhibited the tendency to crook in an 8-year-old plantation of slash pine. Among other trees in the plantation, only 44 percent had any signs of crook. The desirability of cross-pollination in seed production was emphasized by data showing that in a 4-year-old slash pine progeny plantation, trees resulting from self-pollinated seed were significantly shorter than those produced from seed of the same parent tree resulting from either open or controlled pollination (table 7).

Table 7.--Total height of 5-year-old slash pines having one common parent

Type of pollination	Height	Trees
	Feet	Number
Wind	4.6	27
Cross (xG5)	4.6	69
Cross (xG11)	4.8	68
Selfed	3.7	25

A start was made with a small arboretum at Olustee, Florida, composed exclusively of pines not native to the southeastern United States. Two-year-old stock of 33 species and proveniences were planted in lots of 25 seedlings. The purpose of this collection of exotics is to observe growth and development and to breed for desirable characteristics.

The genetics research program at the Station is a correlated effort with the active cooperation of many organizations. The many studies at the various research centers will provide factual data at an increasing rate for many years to come.

PRUNING

Slash Pine Pruning Schedule Proposed

Pruning slash pine plantations can be accomplished economically in a two-step operation. A study on the George Walton Experimental Forest in Georgia indicates that slash pine planted on a good site can be artificially pruned first at 5 or 6 years of age to a height of 8 feet. At 10 or 12 years the pruning can be extended to 17 feet. By this method the knotty core of the butt log is held to minimum size. At no time is the crown ratio reduced below 50 percent of height; thus rapid growth can be maintained.

Bud Pruning Not Recommended for White Pine

Bud pruning is not recommended as a method of pruning eastern white pine. In bud pruning, all lateral buds and branches are removed except on $1\frac{1}{2}$ to 2 feet of the stem at the base of the tree. Each succeeding year all the new lateral buds are either rubbed or cut off, leaving an erect stem terminating in a single living bud. This is continued until at least one log-length of stem is entirely free of branches. A test at the Bent Creek Experimental Forest in North Carolina showed that this method is expensive because prolific lateral bud replacement necessitates more than one pruning each season. The bud-pruned trees seem to have an unusual attraction for the white pine weevil (table 8). A bud-pruned tree successfully attacked by weevils is seriously deformed and retarded.

Table 8.--Incidence of weevil attack on unpruned and bud-pruned white pine

	Number of white pine trees		
	Weeviled	Not weeviled	Total
Bud-pruned	1/ 21	147	168
Unpruned	3	196	199
Total	24	343	367

1/ Chi-square tests indicate statistical significance at the 1-percent level of probability.

THINNING

Precommercial Thinning Aids Diameter Growth of Slash Pine

A commercial pulpwood thinning netting $12.00 per acre stumpage was made in a 20-year-old slash pine stand in Florida, which had been precommercially thinned to 6-by-6-foot spacing 10 years previously at a cost of 1 man-day per acre. The unthinned portion of the same original stand still does not contain enough stems of merchantable size for a pulpwood cut.

A light precommercial thinning (leaving about 800 trees per acre) continued to show the highest rate of growth in a study of stand density 19 years after precommercial thinning in Florida. The data in table 9 are from a 26-year-old slash pine stand precommercially thinned in 1935 at the age of 7 years. A commercial thinning was made in 1945, and total production was computed after an inventory in 1954.

Table 9.--Diameter, basal area, volume, and growth of 26-year-old slash pine thinned precommercially to different density when 7 years old (acre basis)

Degree of thinning, 1935 (and number of trees left)	Volume cut 1945	Avg.d.b.h. 100 best trees, 1954	Basal area 1954	Stand volume 1954	Mean annual growth 26 years
	Cords	Inches	St.ft.	Cords	Cords
Heavy (200)	--	11.54	105.5	34.5	1.33
Moderate (400)	5.9	11.40	120.2	40.2	1.77
Light (800)	8.8	10.05	151.1	52.6	2.36
Check	6.2	9.17	149.7	42.1	1.86

Pine Growing Space Study

On the Hitchiti Experimental Forest, 72 plots--which are part of a regional study of growing space for loblolly pine--were remeasured 5 years after installation. Of significance was the finding that gross cubic growth during the 5-year period was correlated only with site index. Age and stand density over the range sampled had no real effect upon the per-acre growth. As only five plots of this study had an initial stocking below 80 square feet basal area, it was decided to reduce the stocking on 19 of the uncut plots so that for the next period a range of 25 square feet to 170 square feet basal area is being carried. Other installations of this same study involving 59 plots on the Santee Experimental Forest and 24 plots in Virginia were remeasured during the past winter, and the data are in the process of analysis.

A working plan has been approved, and installation started on a large study of growing space for slash pine in Georgia and Florida. The active cooperation of several private companies is involved in this study. A similar project also will be started in the shortleaf pine type as soon as resources permit.

FINANCIAL ASPECTS

Skidding time per M.b.f. is not affected by the amount of the cut per acre, but felling and bucking time in mountain hardwoods are closely related to the volume cut (fig. 19). These results were obtained from an analysis of the data from logging more than 1400 acres by both hand and power methods in the large-scale test of management systems on the Bent Creek Experimental Forest.

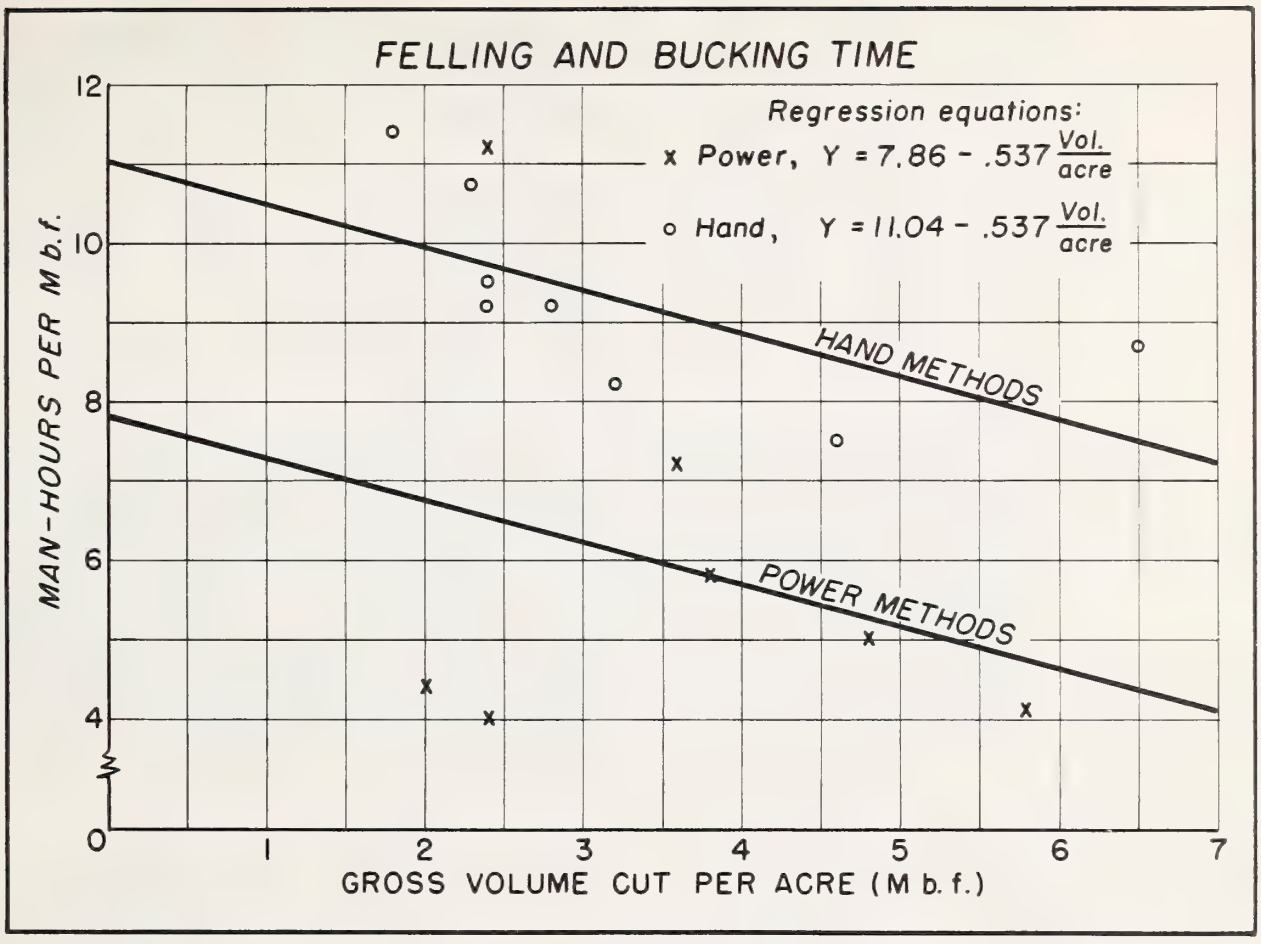

Figure 19.--Relation of volume cut per acre to felling and bucking time using hand or power tools.

During the manufacture of mountain hardwood lumber it was shown that sawing extra thickness (over 4/4) at band mills increased the dollar value an average of $6.50 per M.b.f. The effect varied with species as shown by the following tabulation.

Species	Increase (Dollars per M.b.f.)
Yellow-poplar	1.50
Ash, birch, buckeye, scarlet oak, sugar maple, and red maple	3.25
Black cherry, chestnut oak, and white oak	8.80
Northern red oak, and black oak	10.50
Beech	15.75
Average of all species	6.50

A mill-scale study was made of the grade-yield of mountain pine logs for a location in North Carolina. The differences in percentage grade-yield between this study and both the Piedmont and Coastal Plain mill-scale studies

reported last year emphasize the importance of local grade-yield information. Grading the logs by the "Interim U. S. Forest Service" log grades will separate the logs into quality groups, but the percentage grade-yield from one grade of logs in one locality will differ from that of the same grade of logs in another location. This difference is a result of the past history of the forest stand and environmental factors affecting the quality of the wood, as well as the particular conditions of manufacture of the logs into lumber. Local grade-yield studies provide on-the-spot grade recoveries which are more applicable for that area and condition than any values measured elsewhere.

WIND DAMAGE

Occasional high winds take a small but regular toll of seed trees left after harvest cuts of pine in the Coastal Plain. Severe winds of hurricane force intensify the damage and may result in a substantial loss of standing timber in a short period.

The center of Hurricane Hazel passed less than 100 miles west of the Bigwoods Experimental Forest in northeastern North Carolina between 3:00 and 5:00 p.m. on October 15, 1954. An inventory of the pine mortality was made on 1,020 acres of the Forest. The damage was extensive. Winds up to 100 miles per hour were reported in eastern Virginia and Carolina. The soils were dry and firm, as there had been no rain for 2 weeks, and only 0.85 inch fell during the storm. Most of the damaged trees were broken, not uprooted. Trees with heart rot, cankers, stump rot or worm holes gave way at the point of defect; forked trees parted at the crotch; and sound trees splintered at various points from within the crown to ground level, but generally within the first two logs of the 4- and 5-log trees.

The large-scale test of management systems on 40-acre blocks on the Bigwoods Forest afforded a fine opportunity to observe the relation of hurricane damage to the system of management. The greatest damage occurred in areas with scattered large seed trees. There were five compartments containing 180 acres of stands averaging 967 board feet in 2 seed trees per acre. The volume loss in these areas was 59 percent. Two uncut stands totalling 40 acres lost 9 percent of their volume. Thirteen selection system compartments totalling 454 acres, where one to several cyclic cuts had removed many of the poor-risk trees, lost only 4 percent.

The severity of damage was directly correlated with the average size of seed trees left and the extent of exposed edges of the stand. The exposure of stand edges on the margins of these 40-acre compartments would be more or less representative of small timber tracts in general.

Figure 20 illustrates the effect of "endemic" and "epidemic" wind upon stands of residual seed trees. Figure 20 A was taken in a seed tree stand some time after a very localized high wind had caused some loss. This picture was taken the afternoon before Hurricane Hazel struck. The same view is shown in 20 B several days after the hurricane.

Figure 20.--A, Broken trees in this stand of mature loblolly pine seed trees on the Bigwoods Experimental Forest show the extent of damage caused by a typically local summer windstorm. B, Same area after Hurricane Hazel had passed by.

GEORGE WALTON PILOT-PLANT AREA

The initial 5-year cycle of management on the 2300-acre longleaf-slash pine pilot plant on the George Walton Experimental Forest in south-central Georgia was completed June 30, 1954. Broad accomplishments were:

1. The investment was successfully protected from wildfire where burning had been traditional for generations and where organized protection other than that afforded by the Station and its cooperator was lacking. Prior to establishment, one-third of the timberlands burned annually. Since then, only 12.9 acres have burned over (one-half of 1 percent).

2. An integrated utilization program based on silvicultural principles was substituted for destructive turpentining and hit-or-miss cutting to minimum diameter limits.

3. Hardwood control and the pruning of planted pine were found to be of such economic advantage that the cooperator has since taken the lead in urging their prompt application elsewhere in the territory.

4. The program of utilization paid the costs of protection, planting, improvement, maintenance, and management while showing a reasonable margin for profit. Although such income was derived from salvage-improvement measures, the forest inventory at the beginning of the second 5-year period showed roughly twice as much volume in round, second-growth sawtimber as was left after the initial improvement cut.

The utilization program is based on a 5-year cutting cycle, in which approximately one-fifth of the area is cut annually. During the first cycle, sawtimber was marked for removal some years in advance of the cut. Designated trees were then worked on a rapid schedule for naval stores. Although only 56 percent of the area bore pine timber in merchantable quantities at the outset, the annual financial situation per gross acre (averaged for the first 5-year cutting cycle on three of the five blocks) was as follows:

Gross return per acre		$5.24
Costs		
Hardwood control	.28	
Planting	.11	
Pruning	.11	
Protection	.79	
Marking and scaling	.16	
Buildings and grounds	.14	
Taxes	.16	
Total	$1.75	1.75
Indicated net return per acre		$3.49

A return to Block 1 for the second cut developed certain facts. Following the first improvement cut, which removed 940 board feet of sawtimber in 14 trees, 1634 board feet in 34.3 thrifty sawtimber stems were left per acre. In the following 5 years a second thinning in saw-log sizes was not required. Attention was accordingly directed to pulpwood trees, where a cut of 3 cords per acre in intermediate and suppressed sizes was found desirable (fig. 21). Pulpwood will be the primary crop removed during the second cutting cycle.

Figure 21.--This photo shows the nature of the second cut on the pilot-plant area of the George Walton Experimental Forest. The first cut 5 years before salvaged the old worked-out trees and other defective or poor-risk trees. The second cut is a pulpwood thinning to provide proper growing space in stands of round second-growth timber.

NAVAL STORES

Initially the naval stores program at the Lake City Research Center concentrated on gum production methods, a field in which this Research Center will continue to provide leadership. Naval stores, however, are not now the primary objective in most of the slash and longleaf pine stands of this region. Turpentining is being integrated with other forest use. Hence much of the current research is directed toward facilitating such integration for the benefit of forest owners.

A second major objective in the naval stores program is the development of a high-yielding strain of slash pine especially for gum production. Such a strain has been selected, tested, and proven to yield more than twice as much gum as average slash pine trees. Details of this work were given in the genetics section of this report. The big problem now is propagation of this strain in a quantity sufficiently large to satisfy the demands of the naval stores industry.

INTEGRATION WITH TIMBER PRODUCTION

Tests of Intensive Chipping

To facilitate the integration of gum production with timber production, especially in large ownerships, turpentining on short cycles of 2 to 6 years is preferred by most forest managers to longer cycles of 8 to 10 years. Therefore, we commenced studies of intensive methods of turpentining for obtaining the maximum yield of gum over short periods. Such intensive methods, if proved feasible, would also be more profitable to gum producers than existing methods. Preliminary results indicate that by using a 65-percent solution of sulfuric acid and high streaks, gum yields can be increased by at least 20 percent over the yield obtained with 50-percent acid and streaks 3/4 inch high during the first year of work. These tests must be continued and further refinements in equipment and techniques must be made before intensive methods can be recommended for commercial use.

Standard Methods of Chipping

The standard turpentining method is still biweekly bark chipping with streaks 3/4 inch high treated with a 50-percent solution of sulfuric acid. This method is now used on more than half the total number of turpentine faces in commercial production. Use of the old method of wood chipping is now declining.

In one test, this method has been used continuously for 8 years with an annual yield of 260 barrels of gum per crop. The old method of weekly wood chipping on comparable trees during the same period yielded only 214 barrels per crop annually, and required nearly twice as much labor for chipping.

Gum Yield Tables

Gum yields depend on tree diameter, crown size, and growth rate. These relationships have been worked out for slash pine on sites with an index of 70 feet and for longleaf pine on sites with an index of 65 feet. Results are shown in figures 22 and 23.

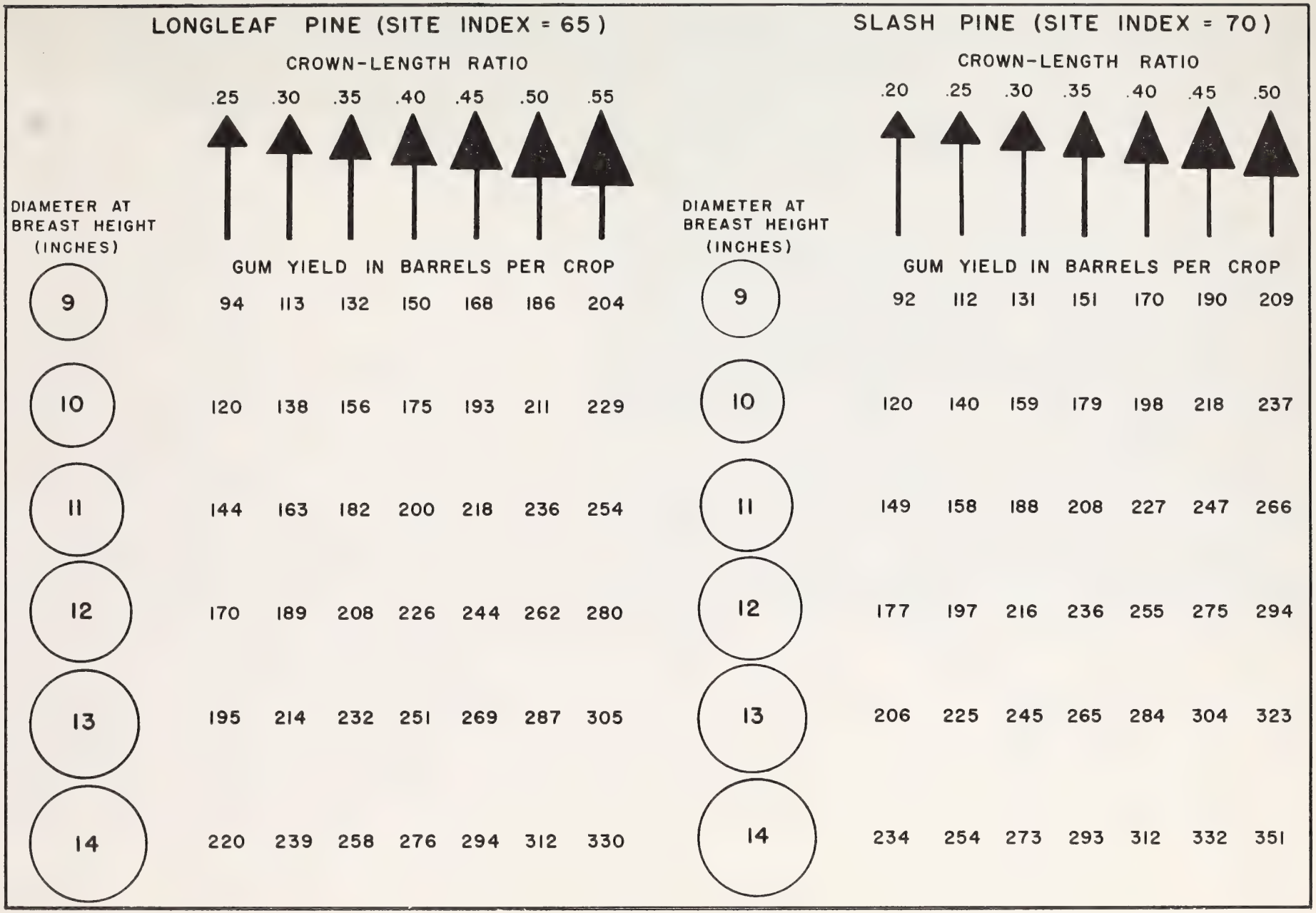

Figure 22.--Relationship of gum yields to diameter and crown-length ratio on bark-chipped, acid-treated trees.

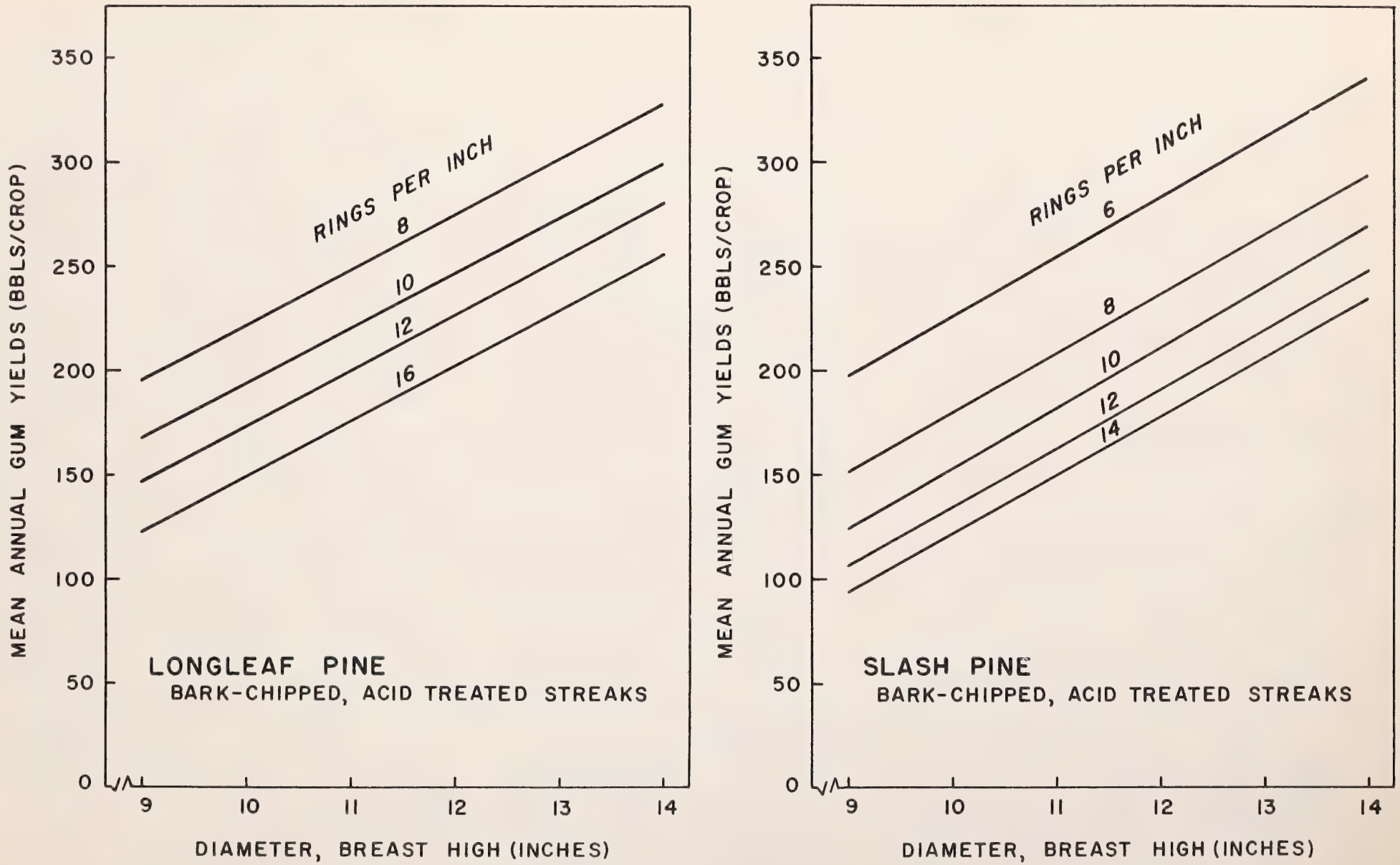

Figure 23.--Relationship of gum yields to diameter and number of rings in last inch of radial growth.

Figure 24.--Turpentining in this 20-year-old plantation of slash pine reduced annual volume growth of a 16-foot section of the tree by 26 percent. Circumference measurements were made bimonthly with the aid of vernier growth bands installed at three heights on the bole of each tree in the study.

Effect of Turpentining on Growth

For two successive years, the annual growth increment in the first 16-foot log of 20-year-old slash pine trees (fig. 24) has been reduced 26 percent by turpentining with either the bark chipping or wood chipping method. The reduction in growth is greatest immediately above the turpentine face and becomes less with increasing height above the ground as shown in figure 25. The change in the amount of the reduction with increasing height is slight and for practical purposes can be ignored.

The value of the potential pulpwood increment lost by turpentining an average tree 10 inches in diameter is less than 2 cents per year at current stumpage prices. The lease value of a turpentine face on such a tree is about 10 cents per year. Hence, turpentining leaves a large margin for profit even after deducting the value of the lost wood increment.

Effect of Black Turpentine Beetle Control Measures on Gum Yields

Some degree of control of black turpentine beetles has been obtained with a basal spray of 1-percent solution of benzene hexachloride in tests made by the Division of Forest Insect Research. In cooperation with this division, a test was made of the effect of this treatment on gum yield. Results showed that the treatment caused a temporary reduction in gum yield that persisted for about one month. Total gum yields for one year of work, however, were only slightly affected.

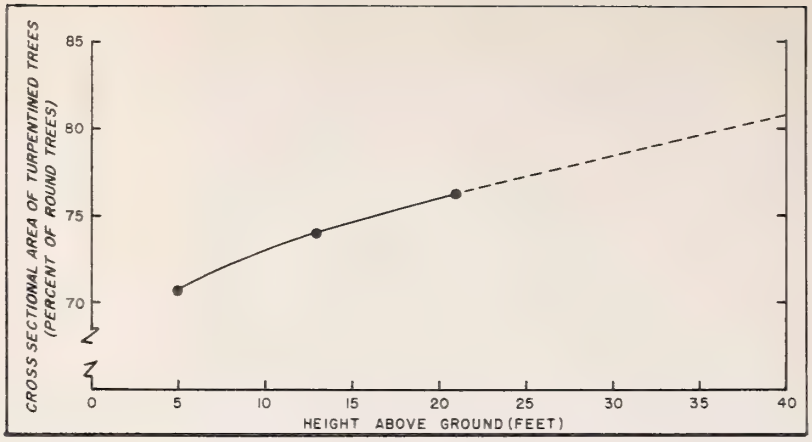

Figure 25.--Effect of turpentining on growth at different heights above ground.

Equipment Development

A new tool for raising cups and gutters installed with double-headed nails has been developed (fig. 26). With this tool one man can do all of the operations involved in raising with a saving in labor requirements of 20 percent. The new tool has been found satisfactory in tests on commercial operations. Drawings and specifications for constructing the tool have been given to six manufacturers at their request.

Figure 26.--New, three-way tool designed for raising tins installed with double-headed nails. One man pulls all nails, raises tins, and attaches cup.

Experimental models of wide hacks and sprayers for 65-percent acid have been constructed for use in tests of intensive turpentining methods.

Considerable demand still exists for a tool that will cut streaks on high faces (up to 7 or 8 feet) but existing tools for this job, known as bark-pullers, are not satisfactory. A new cutting blade for a bark-puller has been designed to eliminate the difficulties encountered with the existing pullers.

FOREST ECONOMICS

Georgia Forest Survey Completed

Georgia has 13 percent less sawtimber now than it had 18 years ago, according to the results of a resurvey of Georgia's forest resources published in 1954.

Pine sawtimber volume decreased 15 percent (fig. 27). In the north central part of the state, there is now only half as much pine sawtimber as in 1936. In the central part the drop was 38 percent, and in the northern part, 45 percent. These losses were partially offset by the 21-percent increase in the southeast section.

For the state as a whole, the volume in pine trees 5.0 to 9.0 inches d.b.h. increased nearly enough to offset the loss of pine sawtimber, as the loss of volume in pine growing stock 5.0 inches d.b.h. and larger was only 2 percent (fig. 28).

Growing stock losses were especially severe in the Piedmont and mountain areas, but gains were recorded in the Coastal Plain.

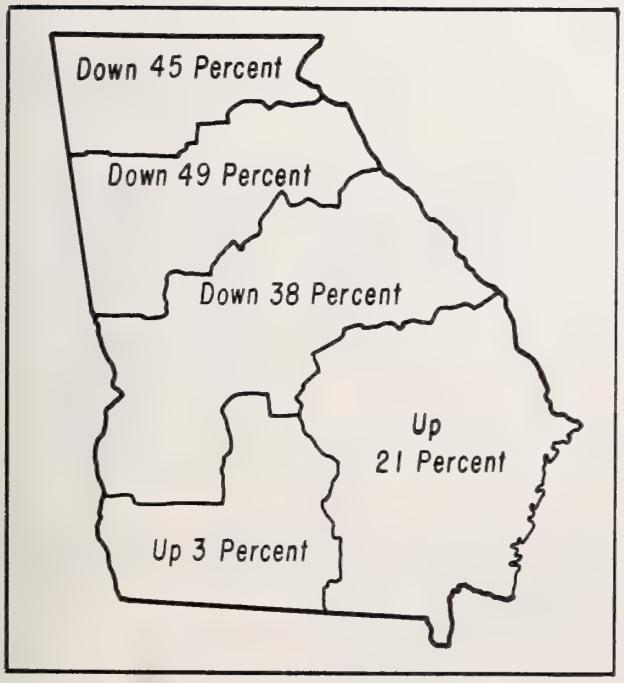

Figure 27.--Pine sawtimber volume in Georgia decreased 3.9 billion board feet, or 15 percent between surveys.

A drop in sawtimber volume is not surprising in view of the sharp rise in demand for saw logs and pulpwood in Georgia. During the period since the 1936 forest survey, Georgia more than doubled its annual production of timber. Pulpwood production jumped from 200,000 cords in 1937 to 2.9 million in 1953. Only the tremendous upsurge in the number of young trees, including pine, prevented more serious losses in timber volume. The number of pine trees increased 41 percent, even though reductions occurred in the number of trees 14 inches d.b.h. and larger (fig. 29). Hardwoods increased even more.

A large part of this improvement in pine stocking resulted from the seeding in of pine on abandoned farmland.

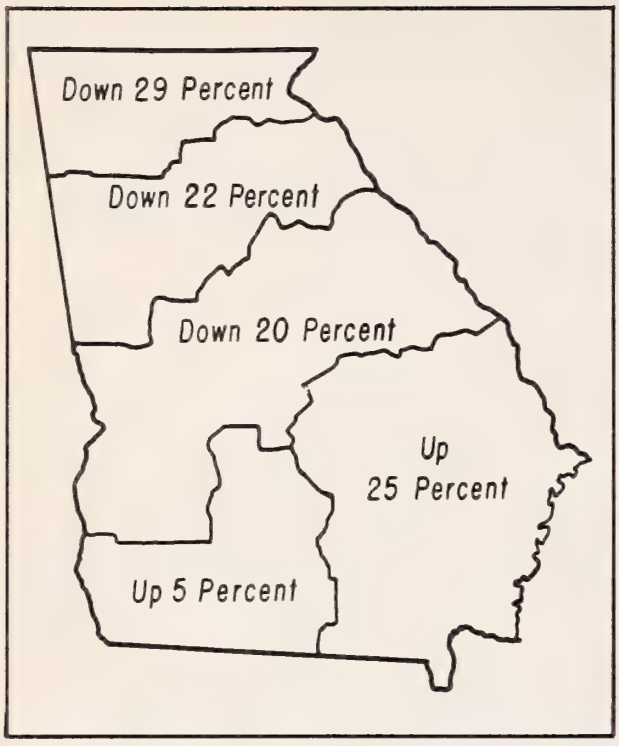

Figure 28.--Pine growing stock volume decreased 2.1 million cords, or 2 percent, between surveys.

Since the first survey, enough abandoned farmland reverted to forest to add more than 2.5 million acres to the forest area. Also, improved fire protection contributed to better stocking. In 1936 an estimated 5.4 million acres burned over in Georgia; by 1952 the burned-over area had been reduced to about 600,000 acres. The planting of pine on more than 300,000 acres has also helped.

Other important trends were revealed by the resurvey. Thirty-four percent of the forested area is now in hardwood types, compared to 22 percent during the first survey (fig. 30). Type conversion is aided by cutting practices which leave hardwoods as the residual stand. Also, the growing space occupied by cull trees is increasing at a rapid rate, and in the period between surveys the volume in cull trees, principally hardwoods, more than doubled.

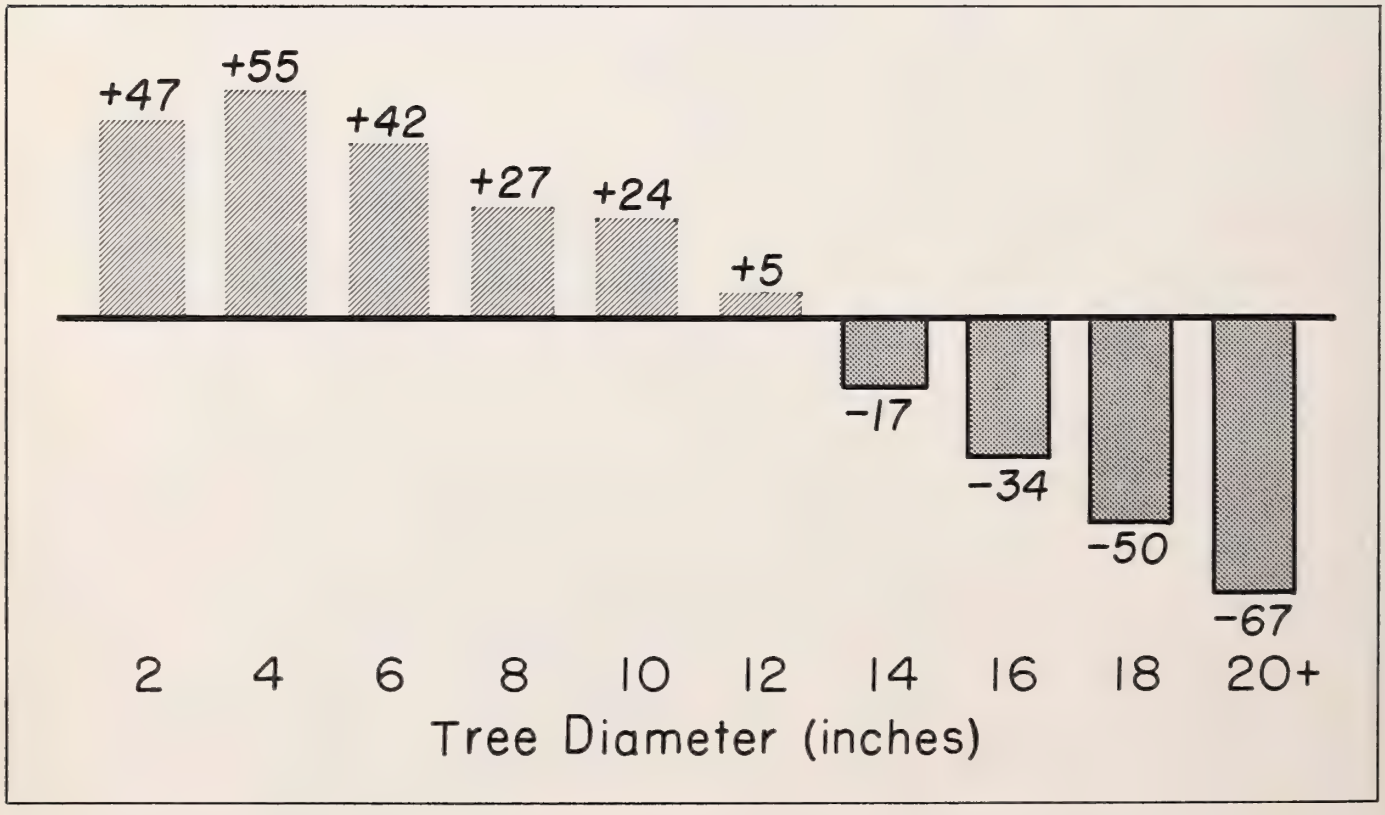

Figure 29.--Percent change in number of pine trees between surveys.

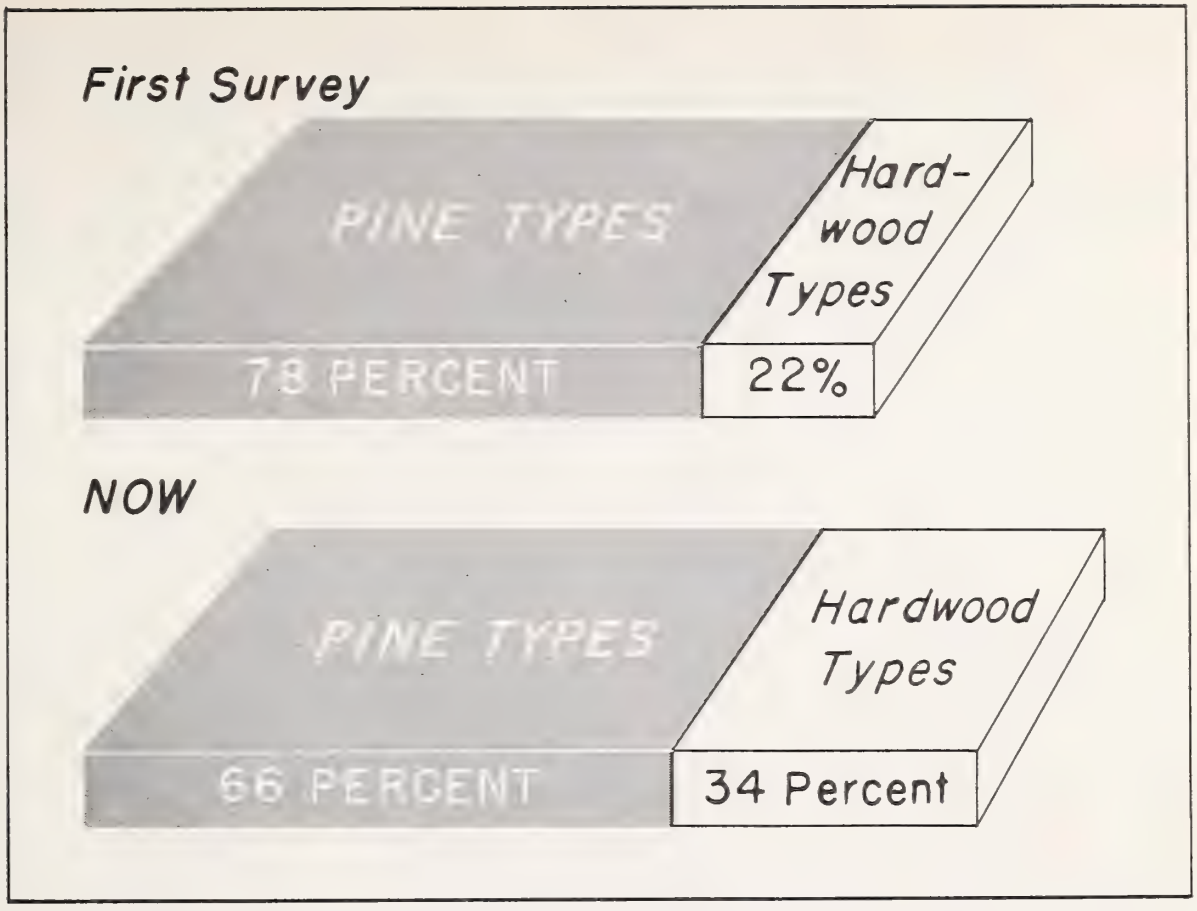

Figure 30.--Proportion of pine type area dropped 12 percent between surveys.

In spite of the large increase in number of trees since the first survey, a fourth of the forest area is still less than 40 percent stocked. Three-fourths of this area is expected to restock naturally, but 1.4 million acres will require planting to bring the land back into timber production.

The findings of the resurvey bring into sharp focus four critical forest problems in Georgia:

1. How to stop the heavy overcutting of pine timber in the central and northern parts of the state.

2. How to keep less desirable hardwood species from replacing pine.

3. How to utilize or destroy the cull trees choking the stands.

4. How to get the poorly-stocked forest land and abandoned farmland into timber production.

Sawtimber in Eastern North Carolina Classified by Log Grade

Quality is an important factor affecting the profitable utilization of the timber resource. To obtain a measure of the quality of the sawtimber in north-eastern North Carolina, an intensive investigation was made at some 60 different locations. Logs in standing and felled trees were graded, using "Interim Log

Grades for Southern Pine" for the pine species and "Hardwood Log Grades for Standard Lumber" for the hardwood species. The results showed that nearly one-fourth (table 10) of the pine volume is in Grade 4 logs. This is significant, since the lumber value of these low-grade logs is only about half that of Grade 2 logs. Also, about one-third of the hardwood volume is in the poorest grade, suitable chiefly for ties and timbers.

Table 10.--Distribution of sawtimber volume by log grade in northeastern North Carolina

Log grade	Pine	Soft hardwoods	Hard hardwoods
	Percent	Percent	Percent
1	3	16	8
2	32	22	27
3	41	28	25
4	24	34	40

1953 Pulpwood Production Continues Upward Trend

Reports of 1953 pulpwood production, obtained in 1954 from all pulp companies drawing wood from 5 Southeastern states, revealed a continuation of the upward trend in wood use. Total production was 8,796,000 cords, or 87 percent more than in 1946. This increase was caused by the expansion of practically all pulp mills in the Southeast since 1946 and the construction of several new mills.

Figure 31 reveals the trend in the production of pulpwood by species groups. The total amount of hardwood, including dead chestnut, cut in 1946 was 717,000 cords; in 1953 the cut had increased to only 806,000 cords. In 1946, however, dead chestnut made up 38 percent of the total hardwood cut; by 1953 it made up only 3 percent. Thus, in the 8-year period the cut of live hardwoods nearly doubled. During the same time the cut of pine more than doubled and in 1953, 91 percent of the total production was pine, compared to 85 percent in 1946.

A Simple Method for Estimating Sawing Cost by Log Size

Sawmill operators have long known that it costs more to saw a thousand board feet from small logs than from large ones. They also realize that they might be losing money on some sizes of logs. However, there was no method, short of a full-scale milling time study, by which an operator could estimate his sawing costs by log diameter. As the result of a sawing time study at 25 small pine roofer mills, a simpler method has been developed. To use it, an operator needs only the tally by diameter and length of logs sawed and a record of operating expenses. By inserting these values in a prepared work sheet, he can calculate the cost per thousand for logs of every size.

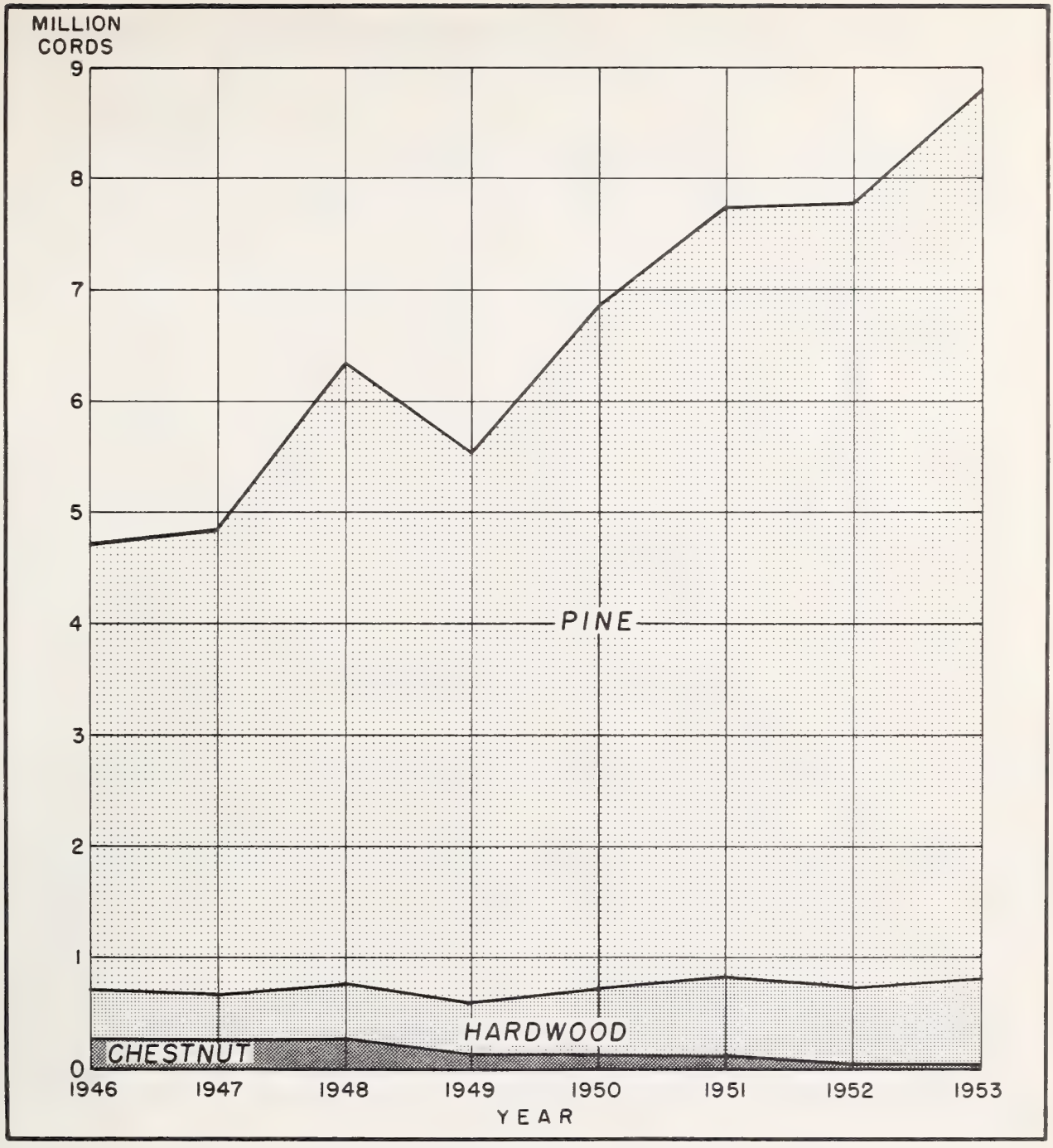

Figure 31.--Pulpwood production in the Southeast, 1946-1953.

This method was made possible by the discovery that the relationship of sawing time to log diameter and length was the same for all mills, regardless of actual production rate. This relationship is shown in table 11. In this table the time required to saw a 7-inch, 12-foot log is taken as 100; the times for other sizes are expressed as ratios of the 7-inch, 12-foot time. Thus, if a mill takes 60 minutes to saw a thousand board feet of lumber from 14-inch, 8-foot logs, it should take $\frac{111}{94}$ x 60 = 71 minutes per thousand to saw 5-inch, 12-foot logs. A faster mill that required only 30 minutes for 14-inch, 8-foot logs should take 35 minutes for 5-inch, 12-foot logs. Since sawing cost varies directly as sawing time, the ratios apply to it equally well.

Table 11.--Sawing time ratios per thousand board feet by log scaling diameter and length

Scaling diameter (Inches)	Length				
	8 ft.	10 ft.	12 ft.	14 ft.	16 ft.
5	167	131	111	98	97
6	138	125	112	102	100
7	119	109	100	91	86
8	109	97	89	81	77
9	105	91	81	75	70
10	100	88	77	70	64
11	98	84	73	66	61
12	97	80	70	62	58
13	95	78	69	61	55
14	94	77	66	58	53
15	92	77	66	58	52
16	92	75	64	56	50

Weight as a Measure of Chippable Sawmill Residues

Paper and board products are now being made from slabs and other solid waste products of lumber manufacture in the Southeast. As the market for these materials expands, the question of how best to measure them for sale or purchase becomes more and more important. The choice is between volume and weight.

Stacked volume, the traditional measure of southern pulpwood, is at best a crude measure of actual wood volume and an even poorer indicator of the cellulose content which largely determines pulping value. Furthermore, the accurate scaling of cordwood on trucks or railroad cars is a time-consuming task.

Stacked volume is an even less efficient measure of slabs and edging strips than of round pulpwood. The greater number of pieces per cord and the greater variety of sizes and shapes result in wider variation in air space. There is also the fact that rough sawmill residues contain two to three times as much bark as roundwood. When it becomes necessary to relate yields of bark-free chips to quantities of rough material, a further complication is introduced. The chips from a cord of wood may occupy from 210 to 291 cubic feet of space.

Adopting weight as standard measure at all stages, from rough residues to chips and on to the final pulp, might avoid much of this confusion. Tests indicate that tonnage yields of bark-free, green or oven-dry wood per ton of slabs or edgings with bark are relatively stable from one batch to another and from one sawmill to another over extensive areas. Needless to say, if gross weight is accurately convertible to bark-free, oven-dry weight, it can also be converted accurately to terms of expected pulp yields.

A sample of shortleaf pine residues gave the following converting factors:

For slabs--

1,570 pounds green wood per ton of green, unbarked material,
or 728 pounds oven-dry wood per ton of green, unbarked material.

For edgings--

1,674 pounds green wood per ton of green, unbarked material,
or 776 pounds oven-dry wood per ton of green, unbarked material.

If truckloads of rough, green slabs or edgings were weighed, application of these factors would give the net weights of bark-free wood, green or oven-dry, with an error of less than 3 percent (two standard errors). To convert the net weights to expected yields of usable chips, one need only make a proper deduction for slivers, fines, and other screenings. Conversions of this accuracy are impossible with volume measurements, and a truck can be weighed in a fraction of the time required to scale its load.

WATERSHED MANAGEMENT

Watershed Deterioration as Observed at Coweeta

At Coweeta, the tests of mountain farming and woodland grazing on steep lands are always of interest to visitors. These "poor practice" treatments were started in 1941 after calibrating the watersheds while in forest cover, and for 13 years thereafter the effects on water and soils were closely observed. The mountain farming practices, in particular, have greatly increased peak flows, flood peak frequencies and sediment production as reported in previous annual reports, but these quantitative increases, though spectacular, are not especially unique or noteworthy considering the severity of watershed treatment. Perhaps the more important contributions from these experiments are the clues they afford as to how much time may elapse before land exploitation adversely affects hydrologic processes in the comparatively deep forest soils of the Coweeta area.

The mountain farm, a 23-acre watershed, was cleared of timber in 1940 and subsequently cropped and pastured, using the typical practices of many mountain people. During the first few years there was little change in streamflow but some increase in soil erosion. Indeed, soil losses, though highly variable from year to year, afford a sensitive index of the cumulative damage to watershed functions in this instance (fig. 32). Prior to clearing there was no evidence of erosion on the area itself, although about 1.8 tons of sand and gravel, on an average, accumulated annually in the weir ponding basin. After clearing, soil losses increased substantially and progressively with extremely high losses sustained in the third, ninth, and thirteenth years, i.e., 44, 114, and 215 tons, respectively. In the ninth year, a single 3-inch storm in July moved some 76 tons of rock and sediment from the watershed, most of this in about half an hour.

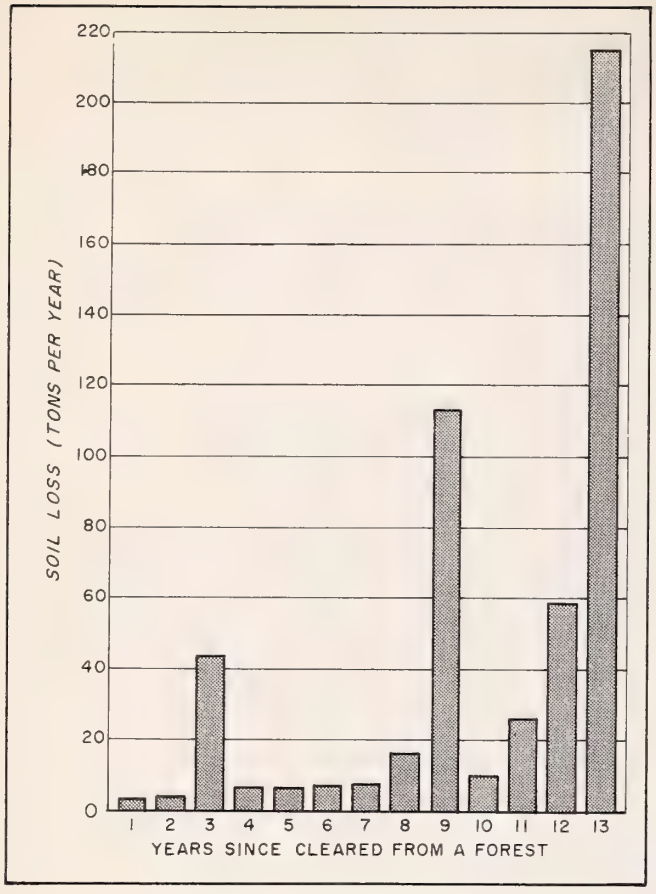

Figure 32.--Yearly soil loss from mountain farm watershed during the first 13 years after the forest was cleared in 1940.

From an area of about 6 acres--in corn for 5 years and grazed thereafter--little soil was lost during the first 2 years, but there was a gradual movement of it downslope within the field itself. By the third and fourth years there were noticeable changes in soil color on the steeper slopes of the cornfield, and some of the soil deposits along the lower edge of the field were carried into the stream during more intense storms. By the sixth year, soils in the more exposed parts of the field had lost the gray-black color of forest loam and turned light-brown to red-brown as more of the subsoil became exposed. Subsequently, as overland stormflow increased on scalded portions of the field, more of it collected in rills and cut through the accumulations of loose soil on lower slopes, carrying much of this into the stream.

On the pastured portion of the mountain farm there was no conspicuous movement of surface soil from one portion of the pasture to another nor little development of rills or shoestring gullies. However, as grazing use continued, these areas produced progressively greater quantities of overland stormflow, which moved off the surface, carrying much soil which immediately muddied up the live stream. Soils over the pasture area became trampled and compacted, and palatable forage was all but eliminated. By the ninth year about 60 percent of the surface area was raw, red subsoil.

Reflecting the adverse effects of grazing on soil structure were the changes in water intake capacity of the mountain farm. Thus in 1949--the ninth year--the infiltration rate as measured for the more trampled lower pasture was 0.56 inch per hour compared with 6.00 inches per hour for the portion in coppice forest. Moreover, when the cornfield was opened to grazing in 1950, the infiltration rate dropped from 3.02 inches per hour to 0.62 inch after only 30 animal-use days of grazing per acre.

The more obvious changes on the mountain farm watershed were those to the stream channel, which began to widen, deepen, and cut its way upslope. By the tenth year the channel banks, originally rounded and clothed with vegetation, were cut away, leaving raw vertical side walls which were then undermined by the increased runoff and higher-velocity stormflow from the mountain farm. These sediment contributions from the channel itself account for a considerable part of the total sediment production from the catchment basin during the tenth to thirteenth years.

In 1954, first treatments to rehabilitate the mountain farm were undertaken to observe hydrologic recovery trends. In April the area was seeded to oats and to Korean and Serecia lespedeza preparatory to planting to white pine in early 1955. Already, soil losses have been scaled down enormously. Thus, after one growing season under plant cover, a 6-inch storm in December moved only 3 tons of sediment from the 23-acre catchment, as contrasted with 1-inch storms of the previous winter which consistently carried off 20 to 30 tons each.

In another experiment, adjacent to the mountain farm, a watershed of 145 acres was fenced and grazed by cattle, an average of 6 head being kept on the area about 4 months each year, May to September. There were no appreciable changes in streamflow or turbidity during the first 7 years. However, from the start there was evident trampling and induced overland flow wherever the cattle concentrated; but little stormflow or soil from these areas reached the live stream because the little which had accumulated in the small ravines and drainage courses filtered out the sediment effectively. In the eighth grazing season stormflow was sufficient to sweep out litter deposits and for the first time open up ravines from source areas down to the permanent stream. There was an immediate sharp upturn in peak flows, and maximum turbidities mounted steadily until grazing use was finally discontinued in the thirteenth season.

Studies of this type, as well as related efforts to reconstruct what happens as watersheds deteriorate or improve, point up the need for more intensive study of hydrologic processes and how these operate over watershed areas. The Coweeta observations also document need for techniques for diagnosing the more subtle or obscure changes in watershed conditions before these progress to the point where substantial damage to water and soils occurs. Where soils are more shallow and have had more destructive use than those at Coweeta, the adverse hydrologic effects of land clearing can reasonably be expected to develop earlier and be of greater magnitude than those observed in these particular experiments.

Coweeta Activities During the Year

Records from 31 stream gages, 26 observation wells, 17 recording and 90 standard rain gages, 6 water temperature stations, and 11 turbidity stations were taken at Coweeta in 1954. Basic studies were continued to develop improved techniques for standardizing watersheds, determine minimum duration of watershed experiments, and predict long-term precipitation-runoff values. In this connection tests in 1954, covering a wide range of elevation and aspect, revealed no consistent differences in the catch of vertically placed vs. tilted rain gages. Some investigators have suggested that tilted gages with the orifice parallel to the slope might provide a more reliable measure of precipitation.

Cooperation continued with graduate schools of several universities, Coweeta supplying hydrologic data for analysis and interpretation. During the year one Master's thesis was completed, and two Ph. D and five Masters' theses were in preparation, all scheduled for completion in 1955.

Much staff time in 1954 was spent in furnishing information about watershed management research and research findings. Some 73 tours of the Coweeta area were arranged for 372 visitors. Staff men gave five talks before group meetings of about 600 people and more than 100 inquiries on technical phases of the program were handled in consultation or by correspondence.

Soil Moisture in the Piedmont

Studies on the Piedmont soils of South Carolina show that the amount of water in the soil at any one time depends largely on the plant cover. Water that enters the soil either soaks deep and becomes ground water, moves laterally and becomes part of a stream, or is used by vegetation. The quantity of water withdrawn from the soil by vegetation depends to a great extent on the plant species, some of which are shallow-rooted and have only a thin layer of soil to draw upon for water, while others are deep-rooted and can absorb water from greater depths.

Assuming there is normal rainfall during the winter, most soils will be at or near field capacity in the spring when plants start growth. Figure 33 tells the story for broomsedge grass and young loblolly pine growing on the same soil and receiving the same rainfall. When growth starts in the spring, trees and grass begin to draw moisture from the soil and this continues throughout the growing season until the winter recharge, beginning in November, restores the moisture deficiency. It is evident from the study that the amount of water removed by the pine is appreciably more than that used by the broomsedge.

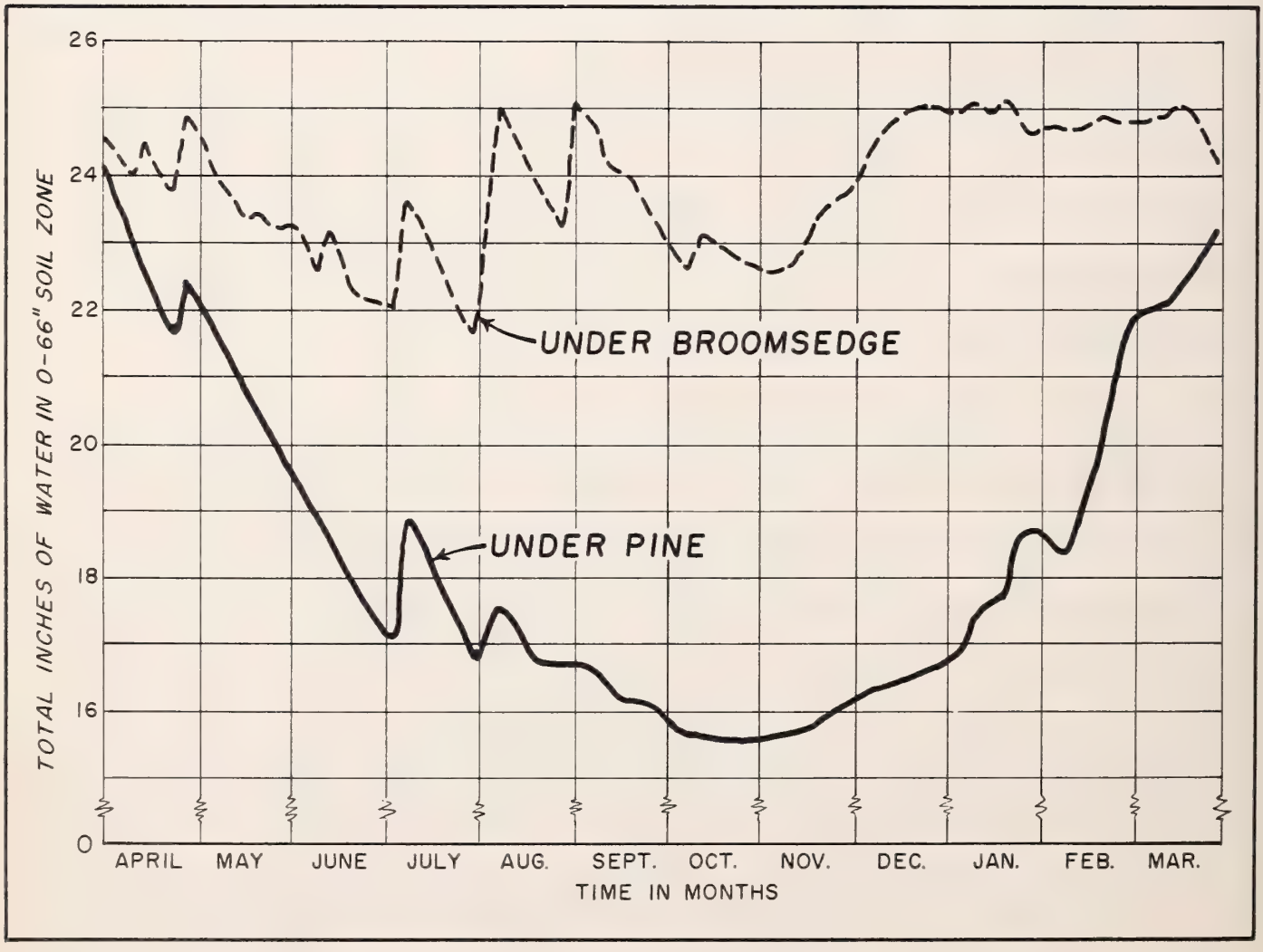

Figure 33.--Total soil moisture in surface 66 inches of soil beneath a young pine plantation and a broomsedge field.

An interesting point is the soil depth from which this moisture is withdrawn. Table 12 shows that the moisture extracted by pine was from the entire sampled depth, whereas the more shallow-rooted broomsedge took it mostly from the surface 30 inches.

Table 12.--Total water removed by pine and broomsedge covers, April 1 to August 1

Soil depth (Inches)	Loblolly pine	Broomsedge
	Inches	Inches
0-15	1.38	1.23
15-30	1.45	0.75
30-42	1.13	0.34
42-54	1.82	0.25
54-66	2.00	0.05
Total 0-66	7.78	2.62

When moisture is removed from the soil by vegetation, the space occupied by the water is available to store future rainfall. Since the pine removes more water from the soil during the growing season than the broomsedge, the soil under pine affords more storage for dormant season rains. Assuming the infiltration capacities of both sites are adequate to take in the water, it follows that sites with pine are superior to those with herbaceous vegetation for holding winter rains on the land.

FOREST FIRE RESEARCH

Relation of Wind Profiles to the Behavior of Large Fires

Work by the Division of Fire Research during the past year may have brought solution of the blowup fire problem considerably nearer. Station Paper 35, "Atmospheric Conditions Related to Blowup Fires," by George M. Byram, published in April 1954, states that fires are most likely to blow up when the following conditions occur simultaneously:

1. Fuels are dry and plentiful.

2. The atmosphere is either unstable or was unstable for some hours, and possibly days, prior to the fire.

3. The wind speed of the free air is 18 miles per hour or more at an elevation equal to, or not much above, the elevation of the fire.

4. The wind decreases with height for several thousand feet above the fire with the possible exception of the first few hundred feet.

The first condition implies that the inflammability of the fuels must be high and that they are capable of producing a large amount of heat. The last three conditions concern the atmospheric effect. The last two of these seem to play dominant roles in major blowups and conflagrations.

The decrease of wind speed with height is associated with a condition in the atmosphere which may be defined as a "jet current" or "low-level jet." Description of these peculiar winds and their possible causes are now beginning to appear in the meteorological journals. It has been found that they accompany phenomena other than extreme fire behavior, such as nocturnal thunderstorms and an unusual roughness in waves at sea.

The low-level jets are of several different types and can be illustrated best by examples taken near the time and place where severe fires have occurred. Curves A and B in figure 34 are the wind speed profiles for 10:05 a.m. and 4:02 p.m. over Roanoke, Virginia, on October 24, 1953, when the Fort Lewis fire burned with high intensity a few miles southwest of the city. The wind speed in miles per hour is shown for different elevations in feet above sea level. The wind direction at any given elevation is shown by the arrows. It will be noted that for curve A the decrease in wind speed begins at or near the earth's surface. In curve B there is a "jet point," or wind speed maximum, at about 1,300 feet above the pilot balloon station (about 500 to 1,000 feet above the fire). Both these wind-speed profiles are extreme-fire-behavior types. Other types and some of the fire behavior characteristics associated with them are described in Station Paper 35.

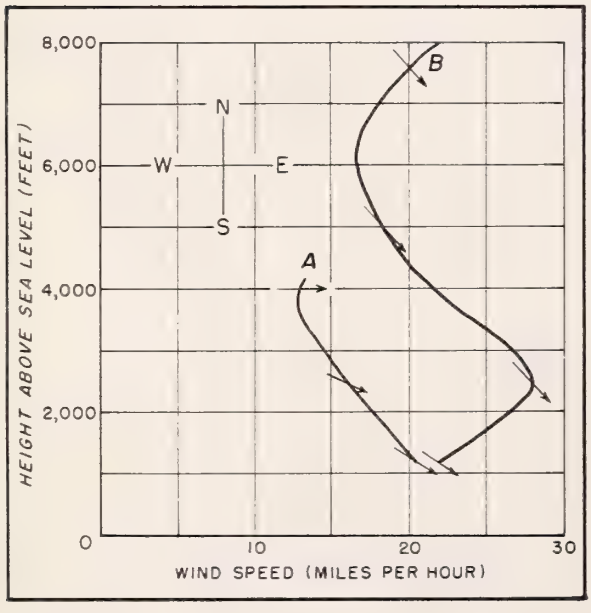

Figure 34.--Curve A is the 10:05 a.m. wind speed profile over the high-intensity fire near Roanoke, Virginia, on October 24, 1953. The wind speed in miles per hour is shown for different heights above sea level. The wind direction at different heights is shown by the arrows. Curve B is a similar profile on the same day over Roanoke at 4:02 p.m. Both curves were plotted from the basic pilot balloon records at the National Weather Records Center of the Weather Bureau.

Following are some of the more important characteristics of extreme fire behavior:

1. A rapid growth of intensity after some critical size or rate of energy output has been reached. This critical size has been tentatively placed at 40 to 60 acres, but the size may vary considerably depending on the quantity of burnable fuel and many other factors.

2. A high sustained rate of spread. This sustained forward rate may be as much as $1\frac{1}{2}$ to 3 miles per hour in flat or rolling country. In the mountains, the upslope spread may be even greater, but the sustained rate might be less. There may be short bursts of spread during which the fire may appear to advance as much as $\frac{1}{4}$ mile almost

instantaneously. The rate of area burned may exceed 1,000 acres per hour but seldom exceeds 3,000 acres per hour.

3. A large, well-developed smoke column is one of the most distinctive features of a blowup fire. This column may be of the towering type which reaches upward thousands of feet when the upper winds are light. This column may be almost vertical in its upper parts. Such a column is shown in figure 35. On the other hand, the column may be of the fractured type in which strong high-level winds shear off the top of the column of rapidly rising gases. The fractured column will show a rather pronounced smoke drift at high levels. For both types the strongest convection is down in the zone where the wind speed decreases with height. This zone is usually more than 2,000 feet deep. The photograph in figure 36 illustrates the way in which strong upper winds can shear off the top of a rising convection column. The fractured type of column seems to cause especially severe spotting, although long-distance spotting occurs with either type.

4. More than any other factor, long-distance spotting is responsible for the high rates of spread that accompany extreme fire behavior. Fire brands are carried high in the convection column by strong updrafts and spewed out at the top for distances of $\frac{1}{2}$ mile or more, and in rare instances for several miles.

   The direction of long-distance spotting may be quite different from the direction of spread of the surface fire. Usually the direction of the upper winds tends to turn clockwise with increasing height, although the direction may not change, or may even turn in a counterclockwise direction. However, the chances are more than 50-50 that long distance spotting will be on the right flank of the surface fire in flat or slightly rolling country.

5. Fire whirlwinds may also contribute to rapid spread and at times may be even more of a safety problem than long-distance spotting. These whirlwinds range from a few feet up to 500 feet in diameter. The larger ones appear to form in the head of a fire and then may move rapidly in advance of the main fire, leaving blackened strips of tree crowns.

   Small whirlwinds often form within a heated and burned area. Because they can readily cross through the fire, they are troublesome and make fire lines difficult to hold.

   Although a good start has been made in determining the underlying causes of blowup fires, there remains the unanswered problem of predicting the atmospheric conditions which make them possible. This accomplished, fire fighters will need to exert the greatest possible effort to contain fires below the critical size. Although it is probable that a few such fires will still escape, they can be attacked with more safety because of a better knowledge of what to expect.

Figure 35.--A towering convection column over which a cloud cap has formed. Behavior details of this particular fire are not available.

Figure 36.--The effects of strong upper winds in fracturing a convection column. Such fractured columns can cause spotting at considerable distance ahead of the main fire.

FOREST UTILIZATION SERVICE

The Forest Utilization Service engaged in a variety of projects during the past year aimed at analyzing the utilization problems of the area, research into new uses for wood, assisting in research projects of the Forest Products Laboratory, encouraging and assisting other agencies in forest utilization research, developing new cooperative programs in hardwood research, conducting short courses and conferences in utilization subjects, and giving talks to further the knowledge of wood utilization.

The Utilization of Wood Residue

A major activity during the year involved a study of the quantity, quality, and availability of wood residue from wood-using industries in North Carolina. Field contacts supplemented by mail canvass resulted in a report that will be published by the State of North Carolina early in 1955. The study revealed that wood manufacturing industries of North Carolina produce about 179 million cubic feet of wood residue each year, more than half of which results from the operation of small sawmills. At present, about 34 percent of this wood residue is left at the sawmill site or burned for disposal, and another 40 percent is burned to produce power to operate the plants. Approximately 10 percent is given away and only about 16 percent finds a sale. Approximately 33 million cubic feet of softwood waste and 74 million cubic feet of hardwood waste are available for new industry at a moderate cost. The report goes on to describe the many potential uses for this class of material (figures 37 and 38).

Knowledge of use of wood residue for soil improvement was advanced during the year by Dr. F. E. Allison, of the Agricultural Research Service, Beltsville, Maryland, who is studying the decomposition rates, toxicity, and other characteristics of bark and sawdust from a number of native species. The Forest Utilization Service supplied Dr. Allison with bark and sawdust from loblolly pine, chestnut, yellow-poplar, and cypress.

A summer meeting of the Forest Products Research Society in South Carolina featured the use of wood residue for chips for pulp and paper or for fiberboard plants. Considerable interest was aroused, and a number of plants in the area are now making plans to convert wood residue into usable chips for industry.

Hickory Task Force

The Hickory Task Force was organized and is sponsored by the Forest Utilization Service with an aim to gathering presently known information about this species for a series of publications designed to encourage the utilization of hickory. Subject matter committees were organized and have been active during the year not only in assembling existing data but in conducting additional research on this species. An Executive Committee meeting of the group reviewed the progress of the committees and made plans for the publication of approximately six of the reports during 1955. Manuscripts on the chemistry of hickory and the veneering of hickory have been completed and are ready for review and publication.

Figure 37.--Mountains of shavings usually accompany planing mill operations.

Figure 38.--Much of the short lumber and waste material at this sawmill could go into dimension stock rather than be cut up as fuel.

Wood Seasoning

If wood were properly seasoned before being put into use, a high percentage of the problems encountered would never appear. The use of improperly dried wood in houses, buildings, furniture, and so on results in tremendous losses from decay, termites, stains, finishing failures, and cracks. Because of the importance of this problem, considerable time was spent by Forest Utilization Service personnel in attempting to get present knowledge put into practice. Two kiln-drying courses were conducted in cooperation with North Carolina State College School of Forestry, and two meetings of the Southeastern Dry Kiln Club were planned and arranged by the Forest Utilization Service. A special trip was made over the South to study the kiln drying practices employed by producers of southern pine. Studies were made of oak stain resulting from improper drying practices, and recommendations for corrective measures were made to plant owners. Numerous inquiries on the subject were handled by correspondence and by plant visits.

A brief study was made of veneer drying practices throughout the territory in an effort to further understand the problems of this industry and to make recommendations for the betterment of veneer drying, particularly the reduction of end waviness in veneer.

Grading of Logs and Other Products

The Forest Utilization Service has been very active in the development and use of grading systems of logs and other forest products. During the past several years, work has been concentrated on the development of southern pine log and tree grades. A simplified system for applying log grades was developed and described in a pocket-size publication. A grading stick was also developed to simplify the process of pine log grading. Other agencies were encouraged to conduct additional grade-yield studies to supplement present information on pine log and tree grades.

A second conference was held on hardwood veneer log grades, at which time past work was reviewed and plans made for conducting additional studies during the coming years. During 1954, the Station issued a report on defects in hardwood veneer logs.

Strength of Wood

During the year, longleaf and slash pine poles were selected and shipped to Madison, Wisconsin, for the nation-wide ASTM pole testing program currently carried on with native pole species. The slash and longleaf pine poles were obtained from both private land and National Forest land and were peeled and inspected at the Taylor-Colquitt Wood Preserving Company, Spartanburg, S.C., before being shipped to Wisconsin. Following completion of tests on untreated poles, additional poles of the same size and quality will be obtained and treated before being shipped to Wisconsin for tests.

Hurricane Hazel left a path of destruction along the coast of North and South Carolina in October. Lindgren of the Forest Products Laboratory and Smith followed in the wake of the hurricane a few days later and secured a

pass to inspect the damage at Windy Hill Beach, South Carolina. They found that wood and masonry alike succumbed to the combined forces of high water and heavy surf caused by the hurricane. Masonry structures were usually almost completely demolished (fig. 39). Wooden structures were severely damaged, especially those supported on a footing foundation. A few structures tied solidly to a full concrete slab suffered less damage (fig. 40). An outstanding example of no damage surrounded by demolished houses was a cottage built on wooden posts securely fastened to deep concrete footings (fig. 41). From observations at Windy Hill Beach it was obvious that at the lower elevations waves washed out almost any kind of foundation and that no type of construction could withstand their onslaught. By building on sites several feet higher and using solid slab foundations or stilt-type foundations, the danger of destruction is greatly minimized. Although the damage by wind was severe at Windy Hill Beach as well as at many inland points, the greatest loss occurred from water damage.

Hardwood Utilization Research

In 1955 Congress provided funds for hardwood management and utilization research in the Southeast. This work is being centered at the Athens-Macon Research Center with headquarters at Athens, Georgia, in cooperation with the School of Forestry, University of Georgia.

Because this project was started late in 1954, permanent personnel were not secured until late in the year and their activities were limited to preparing working plans and getting research projects under way.

Cooperation was arranged with the University of Georgia for the construction of a modern cross-circulation Moore Dry Kiln. Plans were also completed for conducting several cooperative aid studies with the University of Georgia during 1955.

A cooperative aid project was developed with the School of Forestry, North Carolina State College, for the conduct of five research projects by graduate students. These projects are: (1) the development of methods for devising hardwood veneer log grades, (2) a study of the short log bolter mill as compared with the conventional small sawmill in producing furniture dimension stock from hardwoods, (3) development of better methods for making patched strip core from low-grade hardwood lumber, (4) the development of quality control techniques for controlling the grade-yield of hardwood lumber at small sawmills, and (5) a study of the use of low-grade hardwoods for the manufacture of pallets. Most of these projects were well under way at the close of the year.

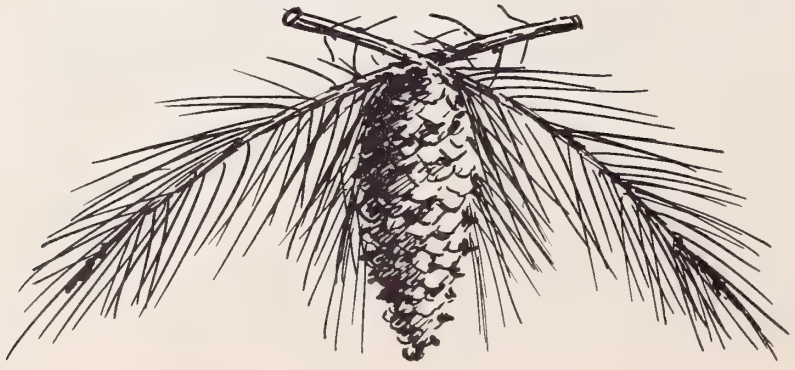

Figure 39.--A completely demolished masonry-constructed home following Hurricane Hazel at Windy Hill Beach, S. C.

Figure 40.--The house on the left was bolted to a solid concrete slab foundation and suffered much less damage than other houses on footing foundations such as the one on the right.

Figure 41.--This cottage built on stilts and tied to deep foundations suffered practically no damage from Hurricane Hazel although surrounding houses were almost demolished.

RANGE MANAGEMENT

During 1954, the Southeastern Station's fourteenth year in Range Research, several significant events reshaped the program. First, USDA reorganization terminated Forest Service research in artificial revegetation and most aspects of plant control research. Next most important, perhaps, was the shift in leadership at the Director's staff level, Shepherd being transferred to Washington and replaced by Woolfolk. The year also saw the transfer of Ralph Hughes from Plymouth, N.C. to Tifton, Ga. Finally, Range Management research was commenced in south Florida, with the development of basic information for a range project analysis and initiation of one line project.

Coincident with these events came the realization that certain changes in the range-livestock industry have occurred in the Southeast during recent years. One of these is the lessening of emphasis on beef production in the Carolinas and increased importance of the industry in the Georgia Coastal Plain and throughout Florida. Since 1945, beef cattle numbers have declined by 1 to 5 percent in the Carolinas and Georgia and increased by 37 percent in Florida. As of early 1954, 50 percent of the beef cattle in the 4-state area were in Florida, and 67 percent were in Florida and the Coastal Plain section of Georgia combined. Another indication of this southward shift of beef cattle is that nearly 42 percent of the grazed area in the Southeastern Station's territory is in Florida and 65 percent of it is in Georgia and Florida combined. Most of Georgia's grazed area is in the Coastal Plain. Still another indication is the relative increase in pasture acreage between 1935 and 1950. In Virginia and North Carolina pasture acreage just about doubled during the period. In South Carolina the increase was only 20 percent, while Georgia's pasture acreage expanded by about 43 percent. In Florida, pasture acreage increased from half a million to nearly $3\frac{1}{2}$ million acres, or more than five times.

The present large acreage of improved pasture by no means spells the end of native range grazing. In the Station's territory there are over 15 million acres of native forest range in use and almost 29 million additional acres that probably could be grazed. Throughout south Georgia and Florida, a pattern seems to be evolving which will give continued importance to native range. Cow and calf operations prevail in that section of the South and for various reasons are dependent upon native range. Once raised to weaning age, steer calves are grown out and fattened for slaughter on the more costly improved pastures. As the development of citrus feeds advances, this pattern should strengthen.

The Range Management research program is geared to this over-all prevailing situation, i.e., gradual withdrawal of effort in eastern North Carolina, continuation with some strengthening in south Georgia, and development of new work in south Florida.

SOUTH FLORIDA RANGES

Many ranges and livestock problems confront the industry on more than ten million acres of wiregrass and native prairie range in south Florida. Periodic, often indiscriminate, burning is the only device, aside from fences, generally used to control or regulate grazing (fig. 42). Ranges severely or too frequently burned often suffer destruction of seedling tree stands and

Figure 42.--Periodic, often promiscuous burning to remove "rough" and undesirable plants frequently destroys seedling tree stands and damages older trees. At best, grazing conditions are only temporarily improved by the practice.

immeasurable losses in grazing values through concentration of cattle and consequent overgrazing. On the other hand, unburned ranges accumulate a heavy "rough" of dry herbage, palmetto, and other undesirable plants and, according to prevailing opinion, thereby lose considerable grazing value (fig. 43). Range stocking rates vary from 4 to over 50 acres per cow per year. Breeding seasons are indefinite and unregulated--many operators run bulls and breeding cows together yearlong. Range cattle generally are of indiscriminate breeding and of poor beef conformation. In an effort to insure adaptability of cattle to warm, moist conditions and a variety of insect pests, a great influx of Brahman blood has been permitted. Only a very low percentage of these cattle can be economically fed to slaughter grades higher than commercial. To rapidly increase breeding herds, many operators retain all heifer calves regardless of size, conformation, color, etc., and reject the well proven practice of herd improvement through rigid culling of breeding cows for failure to attain standard performance. These conditions and the problems they create indicate the need for research and the tremendous possibilities of contributing to greater beef production and the over-all welfare of the range-livestock industry in the Southeast through research.

The first step, of course, is to establish a basis for research by assessing prevailing conditions and establishing priorities for existing problems. This was done during 1954 and the resulting project analysis will be available shortly.

Figure 43.--Low quality cattle and undesirable plants, such as palmetto, contribute to the prevailing low productivity of native forest ranges in south Florida.

Also completed during 1954 was the initial attempt to determine the identity and apparent value of the common range plants in south Florida. In all, 354 different plant species known to have some grazing value were collected, preserved, and identified. This effort included also the recording of information on growth habits, occurrence and other ecologic features. An active field approach to the solution of existing problems will be easier by virtue of this effort.

SOUTH GEORGIA FOREST RANGES

Over sixty percent of Georgia's 800,000 head of beef cattle are concentrated in the Coastal Plain, a section still largely classified as forest land. A high percentage of these cattle subsist for some period each year on the native herbaceous vegetation produced on these forest lands. Thus, the Coastal Plain forests are producing both wood and beef. During the past year new knowledge concerning the use and management of these forest ranges was developed through research.

Drought Proves Value of Native Range

The past growing season, April through September, 1954, was the driest on record throughout the Southeast. As a result, crop failures were common

and grazing capacity of improved pastures was greatly reduced. At Alapaha, Georgia, only 16.9 inches of rain fell during the growing season, compared to the long-time average of 27 inches. Total rainfall for the year through September was only 21 inches at Alapaha, more than 25 inches below the long-time average.

Experimental native ranges at Alapaha held their grazing capacity very well and carried usual numbers of cattle season-long in spite of the drought and without requiring supplements. Cattle weights too were well maintained compared to more favorable years (table 13).

Table 13.--Average weight of steers and dry and wet cows on native forest range
(In pounds)

Year	Mar. 18	Apr. 15	June 10	July 8	Sept. 30
YEARLING AND 2-YEAR-OLD STEERS					
1950-53	484	508	579	597	622
1954	473	520	541	543	537
DRY COWS					
1947-52	628	654	--	737	--
1953	585	620	695	714	773
1954	809	842	871	860	865
WET COWS					
1947-52	625	629	--	619	--
1953	774	748	741	725	719
1954	850	864	843	807	751

Wider use of forest range in 1954 would have prevented substantial sacrifice and loss in many cases. Fuller recognition of native range values can help prevent recurrence of 1954 drought losses.

Cattle-Fire Lanes Pay Their Way

How to provide nutritious winter forage and how to keep wildfire out of the pine woods are two ever present problems in the Georgia Coastal Plain. Research results from Cordele, Georgia, published during the past year show clearly that 66-foot-wide lanes of improved forage plants around blocks of valuable timber retard the spread of ground fire into the timber and provide desired winter grazing for cattle (fig. 44). Dallis grass and carpetgrass stands, well fertilized and over-sown with winter oats, were most effective in retarding fire spread and provided grazing over a longer period. Crediting three-fourths of weaned calf weights to the fire lane, the same as the percentage

Figure 44.--Close grazing and green winter oats on this fire lane stopped the spread of fire into valuable timber.

contribution of the lane to the total feed requirement of cattle grazed in the study, will more than amortize the establishment and maintenance costs over a 10-year period. Any values of the reduced fire risk and resulting improved conditions for successful forest regeneration through seedling survival are added advantages of the lanes. Improved summer grazing is another value, too.

New Study of Timber and Cattle Integration Started

Numerous authorities have proclaimed the primary problem on Southeastern forest lands to be that of integrating timber and livestock production on the same acres. Undoubtedly, many acres can and should be devoted to such dual use, but large areas will also be devoted solely to one or the other, depending on the desires of the owner. Integration of land use is inherently difficult, and approached from the research viewpoint becomes even more so.

During 1954 an integrating study was commenced at the Alapaha Experimental Range. Fifty acres of typical Coastal Plain sandy loam soil were cleared and carefully prepared for seeding of Dallis grass, Coastal Bermuda, common carpetgrass and Pensacola Bahia in a randomized block design. Following the planting of grasses, slash pine seedlings will be planted on a third of the plots at 12 x 12-foot spacing and on another third at 20 x 20-foot spacing. After establishment, all grasses will be over-sown with white clover. The

best known vegetation management techniques will be utilized to integrate livestock grazing and pine production on these areas. This study has unusual possibilities from the seed tree orchard, naval stores, and pulpwood production viewpoints, and is the first of its kind to be undertaken in the Southeast.

TIDEWATER CANE RANGES

Long considered to be the most productive range type in the Southeast, and perhaps in the entire United States, the cane ranges of eastern North Carolina are undergoing a change in handling which seems certain to reduce their contribution to livestock production. Blocking out of ownership into large tracts is withdrawing tremendous acreages from grazing use. These owners, usually large timber and pulp companies, have no intention or desire to enter the range cattle production field, and because of the fire hazard, which is extreme in the cane type, are reluctant to lease grazing privileges to small livestock owners. Dare County, North Carolina, is a case in point. One pulp company owns the entire county, over 200,000 acres. It is classed as cane range but there are only 57 head of cattle in the county according to the 1950 census. Also, greater emphasis on row crop agriculture is evident in the entire cane area. Of nineteen counties in North Carolina which have sizeable acreages of cane range, only 6 have shown an increase in cattle numbers since 1945. Thirteen have shown decreases in cattle. In many cases, too, the supplemental feeds are not available, which research has shown are required to make yearlong use of cane range possible. Regardless of these apparent trends, research was continued during the year and produced new information on how best to use cane range.

Continuous Summer Grazing Detrimental to Cane Range

Grazing the same range every summer for 5 years to remove approximately 60 percent of each year's cane foliage caused a decline in cane leaf size and in height of cane stems. Leaf size was reduced more than an inch, and average stem height by 1.2 feet. Some replacement of cane by other grasses and grass-like plants was attested by a nearly 3-fold increase in density of these species and an accompanying decrease in cane density. Palatable shrubs suffered somewhat, too, under continuous summer use.

On ranges grazed yearlong but only in alternate years, at the same approximate level, cane leaf size was maintained, and stem height suffered only a slight reduction. Continuous winter grazing allowed a slight increase in leaf size and maintenance of stem height over the period. Without any grazing whatever, both leaf size and stem height increased noticeably.

Cattle Management Systems Compared

Early research established the grazing value of cane range and revealed its limitations for yearlong use without liberal supplemental feeds. Recent work has developed information on cattle performance at three levels of maintenance. All three systems provided spring and summer grazing on cane range without supplemental feed of any kind. System A provided fall range grazing without supplements, followed by wintering on improved pasture or stored feeds.

Under system B the cattle received a protein supplement on cane range throughout fall and winter. The remaining system, C, provided unsupplemented range in the fall, and range plus a protein supplement for winter.

Based on late August weights of experimental cows, the three systems were equal. Original breed differences carried through with cross-bred Africander cows considerably heavier than cross-bred Brahmans and Herefords. Calf crops for 1954 varied from 62 percent under A to 56 percent under B and C. Estimated wintering costs per cow, based only on summer 1954 costs of feed, ranged from $19 to $36. From the standpoints of feed costs and calf crop, all three systems proved unsatisfactory as bases for economical cattle production.

Whether cane range can be used yearlong, even with considerable winter feeding, for economical production of beef cattle is still an open question. Locally, entirely as a result of experience, winter grazing is said to be the highest use of cane range. Research to date has not borne out this contention. As was demonstrated, winter grazing with heavy supplementation is costly and unsatisfactory, considering low calf crops and other factors.

FOREST DISEASE RESEARCH

Oak Wilt

Aerial and ground detection surveys for oak wilt were conducted from June through August 1954 in parts of five southern states by crews operating out of the Southeastern Station (fig. 45). The states of North Carolina and Virginia made similar surveys in parts of those states. In Kentucky, State Forest Service personnel did a considerable amount of ground survey work to supplement the work of the crews from the Southeastern Station.

In these five states, a total of 107 infection spots averaging 1.5 infected trees each was found, about half of which were initially infected in 1954. The others were estimated to have become infected between 1949 and 1953. All trees except one, a post oak, were in the red oak group. Heaviest concentration of the disease was in northeastern Tennessee. Table 14 and figure 45 give the results of the surveys in the southern Appalachians except for incomplete data for Virginia.

Table 14.--Known distribution of oak wilt in the southern Appalachian area in 1953 and 1954 1/

State	Counties with known oak wilt trees		Infection centers found	
	1953	1954	1953	1954
	Number	Number	Number	Number
Kentucky	4	7	4	11
North Carolina	3	2	7	24
Tennessee	8	10	30	71
Virginia	5	--	11	--

1/ Oak wilt north of Virginia and Kentucky not reported here.

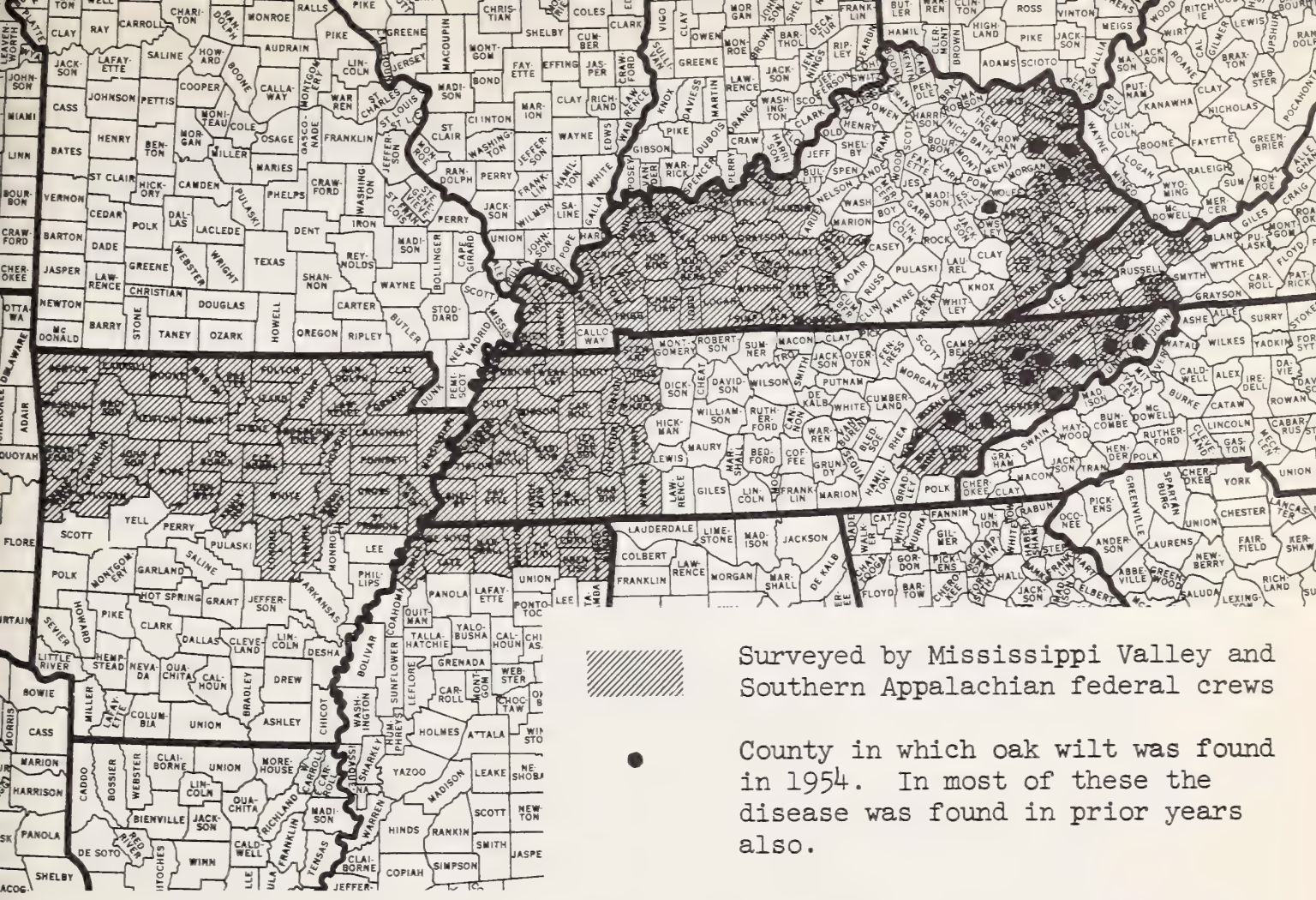

Figure 45.--Oak wilt survey, 1954.

Past results on the use of insecticide sprays to decrease the chances of insect transmission of oak wilt from diseased trees have resulted in adoption of the felling and spraying control method by several agencies. New studies involving 77 trees have shown some summer-cut diseased trees to produce sporulating mats under the bark, but they all formed by late fall, whereas infection appears to take place chiefly in the spring. Summer felling thus becomes an additional control technique.

A study is in progress on the longevity of the oak wilt fungus in 1-inch lumber sawed from diseased trees and subsequently either (1) bulk-piled, (2) sticker-piled, (3) sprayed with pentachlorophenate and sticker-piled, (4) steamed for one-half hour, or (5) kiln-dried. The fungus could not be re-isolated after steaming or kiln-drying. It has, however, been isolated from bulk-piled lumber 13 weeks, and sprayed lumber 10 weeks after felling, and from many boards with moisture contents in the 20's (ODW basis). This study is still active.

Littleleaf Disease of Pine

Littleleaf has been under intensive study for 15 years, during the course of which over 40 publications and 100 reports have been issued. The range of the disease, its cause and effects, and measures for reducing losses have been worked out and are summarized in a new circular published this year.

The research program of 1954 was aimed primarily at selecting and breeding for littleleaf resistance. Controlled pollinations in 1953 between apparently resistant trees yielded over 1,900 seeds this year. Scions have been taken from the parent trees and from other selections and these have been grafted and established at Athens, Georgia, to provide an "orchard" of breeding material.

Open-pollinated progeny from six apparently resistant mother trees were tested for resistance to Phytophthora cinnamomi and found to vary greatly. Large tanks for testing resistance of the control-bred progeny to this fungus have been constructed.

Test plantations of 12 geographic strains of shortleaf on severe littleleaf sites in three states were established a year ago and are now growing well.

Other developments from the 1954 littleleaf research program include the following:

1. Young loblolly pines showed greater tolerance than shortleaf to poor soil aeration and to attack by P. cinnamomi, explaining loblolly's greater resistance to littleleaf.

2. High-nitrogen fertilizers continue to prevent littleleaf in shortleaf pine.

3. On several untreated shortleaf pine plots established in 1944, more than 90 percent of the trees are now dead or dying. Twenty-four out of the total of 31 plots continue to decline, and on the other seven littleleaf has leveled off.

4. Important progress was made in establishing studies on littleleaf control through soil improvement, and on management methods for littleleaf stands.

White Pine Blister Rust

Serious damage from blister rust was discovered during 1954 in a 5-year-old white pine plantation in Monroe County, Tennessee. The trees had been set out in the immediate vicinity of native Ribes. This infection once again points up the advisability of exercising care in the selection of planting sites to avoid those areas where Ribes are so abundant that eradication costs would be excessive.

In the southern Appalachians, native Ribes may occur in localized concentrations at any elevation in cool, moist, rocky coves or so-called rock "bars" and "draws" having rich, black, loamy soil and generally northern exposures. Such sites occur most frequently above 3,000 to 3,500 feet but occasionally also at much lower elevations. Above 5,000 to 5,500 feet Ribes may occur on any rocky site regardless of aspect, providing that plenty of moisture and a suitable soil are present. Cultivated Ribes are frequently found on either abandoned or occupied homesites, and these possibilities should also be considered where old fields are to be planted to white pine.

To date, blister rust infections have been found on both white pine and Ribes in Monroe, Morgan, and Johnson Counties, Tennessee; and in Haywood, Buncombe, McDowell, Yancey, Avery, and Ashe Counties in North Carolina. It has also been found on Ribes in Graham, Jackson, Macon, Madison, Mitchell, Swain, Transylvania, and Watauga Counties, North Carolina; Blount, Carter, Cumberland, Sevier, and Unicoi Counties, Tennessee; and Union County, Georgia. The disease is widespread on both hosts from Virginia north.

Examination of the white pine blister rust plot established in Ashe County, North Carolina, during 1946 shows the following mortality results since establishment:

Table 15.--Blister rust mortality, Ashe County, N. C.

Tree size	Total	Killed by blister rust				
		1946	1948	1950	1952	1954
	Number	----		Percent	----	
Trees over 10 feet high	117	1	2	4	8	8
Trees 1 to 10 feet high	34	0	6	15	32	38
Seedlings	100	0	1	2	8	12

Sweetgum Blight

A decline of sweetgum of unknown cause has been evident in the South for many years, becoming increasingly severe in certain areas, particularly in Maryland. There is some question whether the rapid decline in Maryland, Delaware, and some areas further South and the "leader dieback" known for a long time in the South are different diseases. In the absence of such proof, and because many of the symptoms of the two declines are alike, they are referred to jointly in this report as sweetgum blight (fig. 46).

A survey for sweetgum blight in 1954 by a two-man Federal ground crew was conducted from Maryland to Louisiana. Random strip plots, running at right angles to roads, were taken in representative sweetgum stands until at least 30 sweetgums 5" d.b.h. or larger were tallied by condition. Table 16 shows the results of these talleys.

In addition to the above plots, 1,298 one-quarter acre roadside plots were taken in typical gum stands throughout the survey route, on which the general condition of sweetgum in representative stands was appraised. Table 17 presents the results of these plot talleys.

Table 16.--Incidence of sweetgum blight on 121 strip plots

State	Strip plots	Sweet gum examined	Healthy trees	Trees with up to 1/8 crown dead	Trees with 1/8 to 1/2 crown dead	Trees with crowns over 1/2 dead	Dead trees
	Number	Number	Percentage of trees on strip plots				
Md.	8	199	43	41	10	4	2
Va.	12	256	77	13	6	4	0
N. C.	13	331	72	21	4	2	1
S. C.	16	480	68	24	6	1	1
Ga.	16	477	73	19	7	1	0
Fla.	16	479	70	17	11	1	1
Ala.	16	479	59	25	9	3	4
Miss.	16	480	71	16	9	2	2
La.	8	240	53	32	8	2	5
Total	121	3421	67	22	8	2	2

Table 17.--Incidence of sweetgum blight on 1,298 circular, $\frac{1}{4}$-acre plots

State	Circular plots	No blight	1 to 25 percent trees affected	26 to 50 percent trees affected	Over 50 percent trees affected
	Number	Percentage of circular plots			
Md.	66	12	15	33	40
Va.	146	40	38	18	3
N. C.	144	42	38	16	4
S. C.	142	34	37	23	7
Ga.	170	38	29	26	6
Fla.	133	50	29	10	10
Ala.	209	20	38	31	11
Miss.	174	22	43	28	7
La.	113	33	44	15	7
Total	1298	33	36	22	9

Figure 46.--Sweetgum blight in Maryland.

Sweetgum, as compared with other species, commonly exhibited a die-back of the crown which in extreme cases involved rapid death of the entire tree. The rate of decline has taken alarming proportions in local areas of several states, particularly Maryland and parts of South Carolina, Florida, Alabama, Mississippi, and Louisiana.

Loblolly Pine Spot Die-out

Research has uncovered some important soil characteristics related to this troublesome dying in many loblolly plantations in the Southeast. Data on rate of infiltration and on oxidation-reduction potentials in healthy and diseased stands clearly show that the "die-out" soils tested are poorly permeable and poorly aerated. When ground wells bored in healthy and diseased stands to depths of 1, 2, and 3 feet were filled with water, the level receded much faster in healthy stands, showing greater permeability (fig. 47).

Oxidation-reduction measurements taken every 6 inches to a soil depth of 3 feet in a healthy and a diseased loblolly stand in South Carolina showed the poorer aeration of the soil in the "die-out" stand (table 18).

Table 18.--Oxidation-reduction measurements in a healthy and a "die-out" loblolly plantation
(In millivolts)

Depth of soil samples (Inches)	Oxidation-reduction measurements, made in--					
	Fall		Winter		Spring	
	Healthy stand	Diseased stand	Healthy stand	Diseased stand	Healthy stand	Diseased stand
0- 5.9	218	91	140	-1	79	31
6-11.9	194	96	103	38	71	38
12-17.9	165	82	86	36	60	38
18-23.9	135	90	78	19	59	28
24-29.9	115	58	72	18	44	18
30-35.9	116	52	68	2	35	9

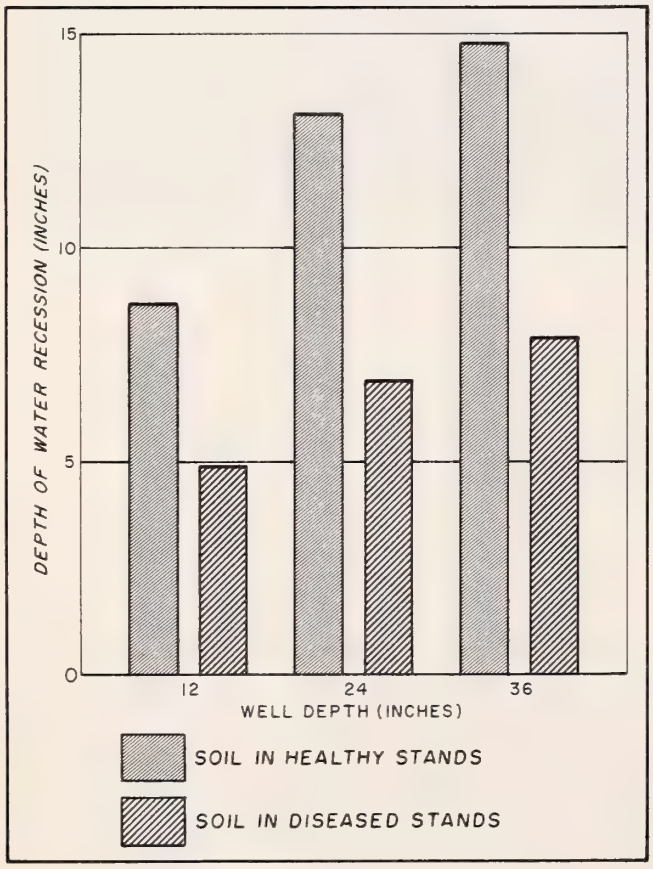

Figure 47.--Water recession from filled wells, in two hours.

Sapstreak Disease of Sugar Maple and Yellow-poplar

During the past 15 years, 198 sugar maple and 144 yellow-poplar trees have been inoculated with Endoconidiophora virescens. Only 15 trees, two of them yellow-poplars, have become diseased following inoculation. Strains of the fungus isolated from sapstreak-diseased maples have killed maples, and from blue-stained yellow-poplar lumber have infected yellow-poplars. Thus, although successful infection appears to be uncommon, both in nature and artificially, the ordinary blue-stain Endoconidiophora appears to be able to act as a quick killer of large trees once it succeeds in invading the vascular system.

A 13-acre plot of 78 large sugar maples in an area where sapstreak has been common was put under observation in 1941. So far, eight have died and two more are diseased. The disease has thus far been identified only on sugar maple near Barnardsville, North Carolina, and on yellow-poplar near Asheville, North Carolina, and Damascus, Tennessee.

Wood Moisture in Ships Under Dehumidification

In cooperation with the Navy, Bureau of Ships, a study is being conducted in Florida on the effect of dehumidification (DH) of inactive wooden ships moored in fresh water, from the standpoints of wood moisture and decay susceptibility. Observations are being made on the effects of DH on the moisture content of different members both above and below waterline. The moisture content of the wood is measured electrically at permanent moisture stations because decay in wooden members is affected by the moisture content. DH at a relative humidity of 45 to 50 percent keeps the bilges dry except in very wet weather. In the ships under DH, the moisture content of most of the wood above waterline is kept too low for the development of decay fungi. The wood below waterline, while drier than when the study began in 1952, is still moist enough at a considerable number of places to support fungi. Some decay is present in superstructures, decks, and frames near deck line, but no definite decay was found in numerous frames bored near waterline.

Nursery Diseases

Studies at the Herty Nursery of the Georgia Forestry Commission have shown that the root rot there resembles that which occurred at the Ashe Nursery, in Mississippi. Control by soil fumigants has been successful. Methyl bromide at one pound per 1,000 square feet has given control superior to ethylene dibromide at $7\frac{1}{2}$ gallons per acre. This suggests that a fungus-nematode complex is involved. The extra cost of methyl bromide can be justified because of the additional saving over the cost of hand weeding nut grass.

Studies on fertilization have shown that nitrogen deficiency is commonly limiting to growth. Liquid applications of ammonium nitrate or urea solution in April and May corrected the difficulty. Some types of chlorosis fail to respond to nitrogen or iron applications.

Irrigation based on gypsum block conductivity readings requires less total water without producing a detrimental effect on the seedlings. A fungus of the genus Diplodia is commonly found on pine seed, but fungicidal treatments of seed before planting have shown no benefit to establishing stands. An outbreak of Phomopsis blight was found on nursery seedlings of Monterey pine.

Miscellaneous Diseases

Pine cankers.--The number of cankered shoots on two Virginia pine plots at Bent Creek have increased 58 and 79 percent in 7 years. New pitch cankers have been tallied almost every year on slash pine plots at Daytona and Olustee, Florida. Important damage from pitch canker, however, is a very local matter. This year a striking case of heavy killing of pole-sized shortleaf by pitch canker in Tennessee was investigated; and a serious mortality of turpentined slash pine in south Georgia is under study, involving cankering of unknown cause.

Virginia pine rust.--A large number of trees inoculated with aeciospores of the new rust, or with sporidia from an undetermined Cronartium on Buckleya have been outplanted for observations on canker formation.

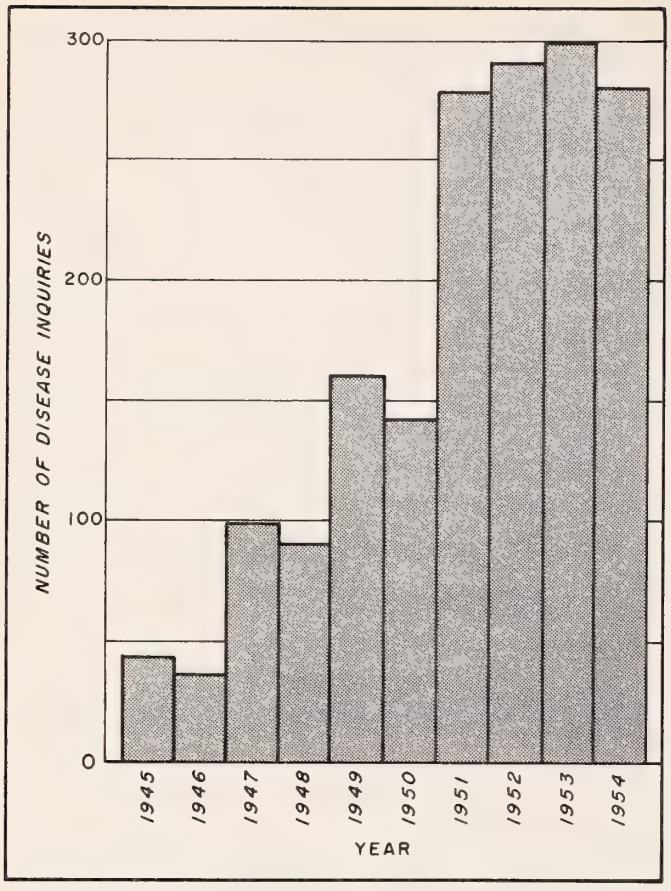

Figure 48.--Disease inquiries made to the Division of Forest Disease Research.

Sycamore anthracnose.--Leaf blight and defoliation of sycamores were widespread over much of the southern Appalachian area in the spring. Infections by the causal fungus Gnomonia veneta were favored by the wet cool weather, leading to the most epidemic occurrence since 1937.

Drought.--Unseasonably dry weather occurred for the third consecutive summer in parts of the Southeast, resulting in drought injury to many trees, especially oaks. This increased the difficulty of detecting wilt-diseased oaks because drought symptoms are superficially similar to those caused by wilt.

Inquiries on Tree Disease Problems

Inquiries handled by the Asheville pathology unit have risen from about 40 per year 10 years ago to about 300 per year currently (fig. 48). This work has become a major activity and is regarded as essential to our clients and helpful to the research group in keeping abreast of disease developments.

FOREST INSECT RESEARCH

On January 1, 1954, the Division of Forest Insect Investigations of the former Bureau of Entomology and Plant Quarantine was transferred to the U. S. Forest Service. Personnel and functions of the former Division were assigned to the Forest Experiment Stations in the Division of Forest Insect Research.

Funds were allocated to the Southeastern Station on July 1, 1954, for research on forest insect problems. These funds have enabled the Station to employ two additional entomologists at Asheville. The research activities of an entomologist located at Lake City, Florida, which were formerly under the technical supervision of the Gulfport, Mississippi, Laboratory, were placed under the technical guidance of this Station. Cooperative funds provided by the State of Georgia have made it possible to employ an entomologist at Macon, Georgia, who will work primarily on insect problems in the Georgia forest nurseries and plantations.

Southern Pine Beetle

This was another year of heavy losses due to southern pine beetle activity in North Carolina, Tennessee, and Virginia. Conservative estimates of timber volume killed by the beetle in these states are shown in table 19.

Table 19.--Volume of pine killed in North Carolina, Tennessee, and Virginia by the southern pine beetle, 1951-1954

Year	Volume killed	Estimated value	Area
	M bd. ft.	Dollars	Acres
1951-52	2,500	37,500	1,500
1953	13,500	202,500	3,000
1954	30,000	450,000	6,500

It is estimated that only 20 percent of this material was salvaged by the larger landowners, and North Carolina and Cherokee National Forests. In many areas, the inaccessibility of the killed areas and small tree size (fig. 49) combined with inadequate pulpwood markets, hindered or made salvage operations impractical.

Figure 49.--Trees of small diameter killed by the southern pine beetle are often difficult to salvage.

Aerial and ground surveys were conducted in both January and June (fig. 50) in cooperation with the Beltsville Research Laboratory to locate areas of infestation on the North Carolina National Forest, Great Smoky Mountains National Park, Cherokee Indian Reservation, and immediately adjoining private lands. Estimates in January showed 44,000 infested pines on all lands in western North Carolina. For the same area 21,000 infested trees were reported in June. The reduction in beetle attacks from January to June was only temporary, since new attacks have occurred at a much faster rate since that date.

Estimates of insect kill in Tennessee were made following each of the North Carolina surveys. Bug kill in January was estimated at 9,600 trees in western Tennessee. By late June the number of infested trees had increased to over 44,200.

A large outbreak of this beetle was reported from south-central Virginia in late 1954. This outbreak is known to be killing a large volume of pine over an area of approximately 1,000 square miles.

Field examinations during December give no indication of a foreseeable decrease in activity of the beetle in the southern Appalachians. If drought conditions prevail again in 1955, continued heavy timber losses may be expected.

Figure 50.--Aerial surveys are made to detect and determine areas of southern pine beetle attack.

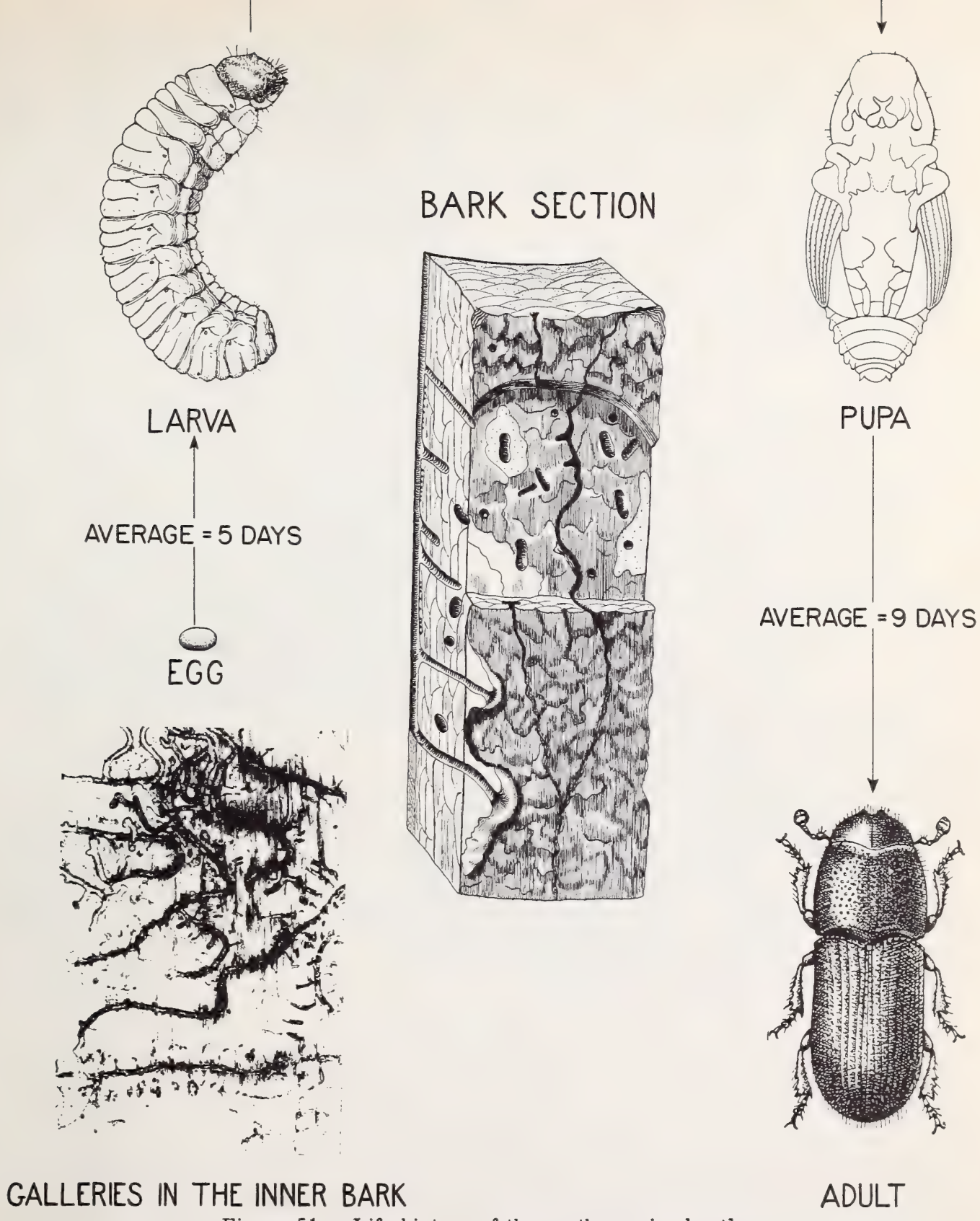

Figure 51.--Life history of the southern pine beetle.

Under provisions of the Forest Pest Act, nearly 25,000 infested trees were chemically treated during the year by federal land managing agencies, the North Carolina Department of Conservation and Development, Log Cabin Association, and Champion Paper and Fibre Company. The Cherokee National Forest has salvaged pine wherever possible and has cut an estimated 2 million board feet of infested timber. Rapid conversion or treatment of infested timber is essential to control this beetle, since it completes from four to six generations each year. Only 40-60 days are required for each individual brood to mature (fig. 51).

Black Turpentine Beetle

Research work on control of the beetle has been in progress at Lake City, Florida. Since a large portion of the population of this insect originates in fresh-cut pine stumps (fig. 52) and subsequently attacks and kills living trees (fig. 53), most of the work has been directed toward development of methods of controlling the beetle by means of stump spray applications. Two methods of control have been developed. One is to prevent the attacks from being made on fresh-cut pine stumps, and the other is to kill the brood after the attacks have been established. These are referred to as preventive and remedial control, respectively.

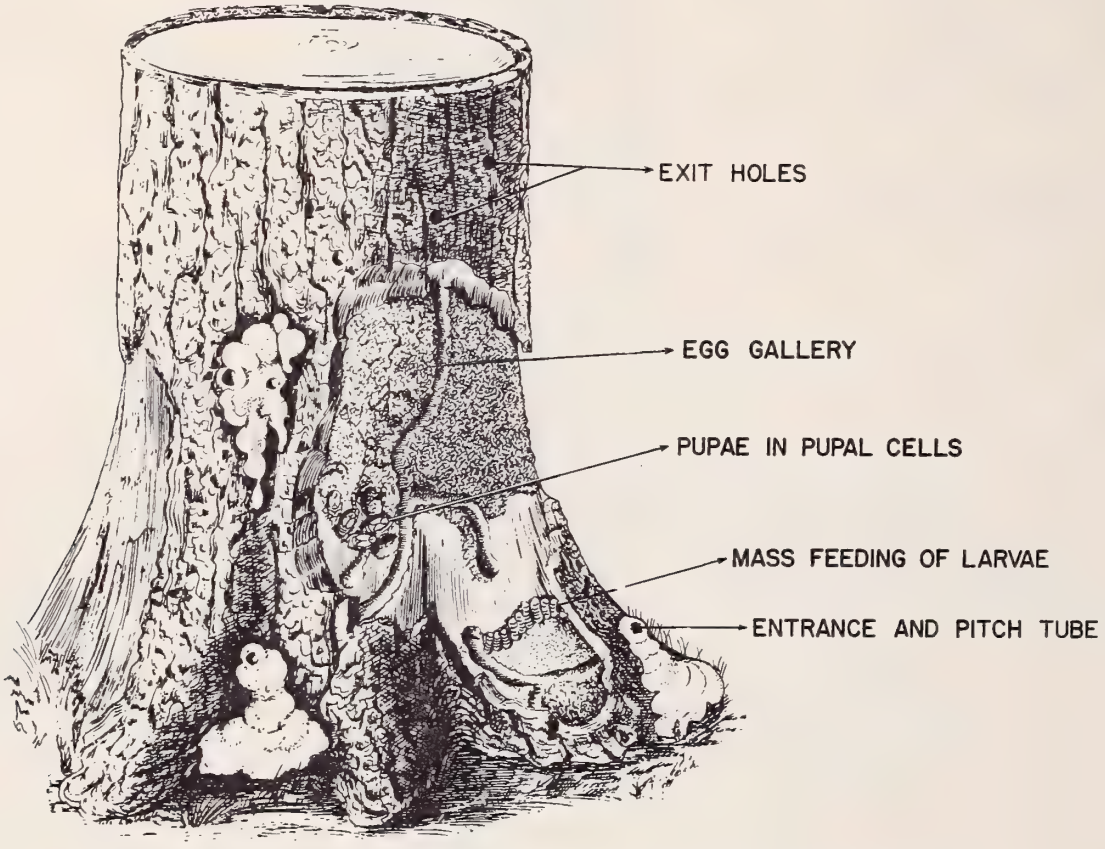

Figure 52.--Pine stump infested by black turpentine beetle.

The results of various tests show that benzene hexachloride at a concentration of $\frac{1}{2}$ percent gamma in dissel oil is the most effective material used in preventing black turpentine beetle attacks on fresh-cut pine stumps and on standing trees. This material remains effective for at least 7 months after application. To obtain the best remedial control, ethylene dibromide should be added to this solution at the rate of 3 pounds per 5 gallons. These sprays should be applied at the rate of 1 gallon for 40 to 50 square feet of bark surface. The loose bark and debris should be sloughed away from the stump to obtain maximum effectiveness.

Pine Engraver Beetles

Drought conditions prevailed generally throughout the Southeast this year, but precipitation deficiency and abnormally high temperatures were particularly

Figure 53.--Attacks on living trees by the black turpentine beetle.

serious in southern Georgia, where some localities experienced less than 25 percent normal rainfall for 8 consecutive months.

Due to the weakening effect of the drought and other factors, such as wildfires, pines in many localized areas were attacked by the pine engraver beetles, Ips calligraphus, grandicollis, and avulsus. By early September, sizeable acreages of pine timber were being killed by these bark beetles. In December, the following Georgia counties were known to have serious Ips beetle outbreaks: Dooly, Pierce, Pulaski, Tift, Turner, Worth, Laurens, and Treutlen. Conservative estimates of the volume of slash and longleaf pine killed by these beetles in the above counties in 1954 is 35 million board feet.

Fall Cankerworm

Aerial surveys during June 1954 showed that 22,300 acres of Appalachian hardwoods were heavily defoliated in Haywood, Jackson, and Transylvania Counties on and adjoining the North Carolina National Forest in western North Carolina. The total acreage of heavy defoliation in this same area in 1953 was 29,500, and in 1952 only 3,700 acres. To date, tree mortality has not occurred on areas which have been defoliated for 3 consecutive years.

Pine Sawflies

Sawflies of the genus Neodiprion caused severe defoliation of several small localized areas in the Southeast, especially in northern Florida. A 25,000 acre tract of pond pine in Berkeley County, South Carolina, which was severely defoliated in 1953, showed less than 25 percent defoliation in 1954.

Pine Tip Moth

The number of reports of severe damage, particularly to planted loblolly pine, have increased considerably over those received last year. Both the Nantucket pine moth, Rhyacionia frustrana, and a species lacking a common name, R. rigidana, were commonly taken in damage specimen collections. The dry weather of the past two seasons appears to be partly responsible for the increased injury. Satisfactory control has been developed for the protection of ornamental pines, but effective and economical methods have yet to be developed for spraying or treating large plantations. Examinations and reports on the Southwide Seed Source Study plots show that tip moths were the most prevalent and serious insect pest of loblolly pine.

Pales Weevil

Reports of girdling of natural and planted pine reproduction by the pales weevil have been more frequent in 1954. This damage is most likely to occur in or adjacent to heavily logged or burned areas. Planting of pines in such areas, within less than one year following removal or severe damage to the stand, is likely to result in considerable seedling mortality due to pales feeding on the bark tissues of the young trees.

Cypress Beetle

During the past few years reports have been received that cypress was discoloring in midsummer in parts of the Southeastern states. This condition was generally attributed to drought. During the past summer it was discovered that swarms of small beetles, Systena marginalis, were feeding upon cypress needles. It now appears that the feeding of this beetle was responsible for cypress defoliation which formerly was believed to be caused by lack of moisture.

The beetles move in large swarms and can be found on only a few trees in an area at any one time. It is possible to travel $\frac{1}{4}$ mile in a pond and see extensive damage without seeing a beetle. They apparently do not remain on a tree for more than 1 to 3 days. Only a few days after the trees are attacked, they turn red.

The activity of the beetle was first noticed in mid-June in north Florida. Discoloration of the foliage became noticeable by mid-July, and by early August it had become very severe and almost universal in some areas. By late August, after one of the driest summers on record, a great many of the trees were putting out new foliage.

Bark Beetle Attacks Grafted Pines

A small bark beetle caused considerable damage to scions of slash pine during the grafting work by personnel of the Forest Genetics Project at Lake City, Florida. In April when the scions began to elongate and the unions seemed successful, the beetle attacks were first noted. Scions were attacked in the lath house and in field replicates over 10 miles away, with losses of approximately 25 percent and 15 percent, respectively.

Normally, this small beetle, which is indigenous to pine areas, attacks the newly felled or dying pines and the tips of branches which are in the process of being naturally pruned. Occasionally it has been recorded as attacking rather healthy branch tips.

PUBLICATIONS

by

MEMBERS OF THE STAFF, INCLUDING COOPERATORS

Calendar Year 1954

ANDERSON, W. C.

Pine sawmilling costs by log size: an estimating method. Southeast. Forest Expt. Sta. Paper 43, 14 pp.

A simple method for estimating the cost of sawing mill-run pine lumber from logs of any size at small sawmills.

BENNETT, F. A.

A practical schedule for pruning planted slash pine. Southeast. Forest Expt. Sta. Research Note 53.

Can prune to 8 feet at 5 or 6 years, and 17 feet at 10 or 12 years without reducing crowns below 50 percent of height.

BENNETT, F. A.

Reduction in growth of interplanted slash pine. Southeast. Forest Expt. Sta. Research Note 55.

One year's delay in $7\frac{1}{2}$ x 15 interplanting in original 15 x 15 spacing was fatal; second planting suppressed by first one.

BENNETT, F. A.

Interplanted slash pine fails. South. Lumberman 189(2369): 166.

Seedlings interplanted to improve plantation spacing are suppressed by rapid development of earlier planting.

BENNETT, F. A., and HALLS, L. K.

The effect of grazing on slash pine seedling survival. Southeast. Forest Expt. Sta. Research Note 58. Also in South. Lumberman 189(2361): 52. Also in Naval Stores Rev. 64(5): 16.

Heavy and light grazing on south Georgia carpetgrass and wiregrass ranges, respectively, had no detrimental effect on the survival of interplanted slash pine seedlings during the first year after planting.

BRENDER, E. V., and NELSON, T. C.

Behavior and control of understory hardwoods after clear cutting a piedmont pine stand. Southeast. Forest Expt. Sta. Paper 44, 17 pp.

Control by cutting lasted little over a year; burning effects lasted 2 years.

BOYCE, J. S., Jr.
Nitidulid beetles released 500 feet away reinfest oak wilt fungus mats. Plant Dis. Rptr. 38(3): 212-213.

Marked nitidulid beetles were recovered on fresh oak wilt fungus mats when released 500 feet from them.

BOYCE, J. S., Jr.
Spraying logs of oak wilt trees to reduce infection hazard. Southeast. Forest Forest Expt. Sta. Research Note 52. Also in South. Lumberman 188(2357): 68

Spraying unbarked logs of oak wilt trees with a mixture of BHC, DDT, and pentachlorophenol is a promising treatment for reducing the possibility of insect spread of the disease.

BOYCE, J. S., Jr.
Hypoderma needle blight of southern pines. Jour. Forestry 52(7): 496-498.

Observations on needle blights of southern pines from 1949 through 1952 show that the fungus Hypoderma lethale is an important cause. Loblolly, pond, and slash pine seedlings were successfully inoculated with the fungus.

BOYCE, J. S., Jr.
Mat formation by the oak wilt fungus on felled versus standing trees. Plant Dis. Rptr. 38(9): 676-677.

Observations in North Carolina and Tennessee showed that wilting trees which were felled during the summer produced mats only during the same fall. Some infected trees that were left standing, however, produced mats the spring following the appearance of wilt symptoms.

BOYCE, J. S., Jr.
Control methods for oak wilt described by forestry experts. The Tenn. Conservationist 20(11): 11, 22.

Current methods of treating wilt-infected trees to reduce their infection hazard are described.

BYRAM, G. M.
Atmospheric conditions related to blowup fires. Southeast. Forest Expt. Sta. Paper 35, 34 pp.

The relation of certain atmospheric conditions, particularly wind profiles, to blowup fires.

BYRAM, G. M.
Air turbulence and extreme fire behavior. Northeastern Logger 2(9): 17, 37.

Atmospheric instability and some kinds of wind patterns set the stage for blowup fires.

CAMPBELL, R. A.
Farm woodland management in the Southern Appalachians, an 8-year summary. Southeast. Forest Expt. Sta. Paper 41, 9 pp.

Returns $3 per acre annually from stumpage alone, or $10 at roadside for stumpage and labor, or $15 at market for these items plus hauling.

CAMPBELL, R. A.
Labor requirements as influenced by volume cut per acre on the Bent Creek Experimental Forest. Southeast. Forest Expt. Sta. Research Note 51.

In increasing the cut from 1.8 to 6.0 MBM per acre, the time per M for felling and bucking (but not for skidding) increased.

CAMPBELL, W. A., and COPELAND, O. L., Jr.
Littleleaf disease of shortleaf and loblolly pines. U. S. Dept. Agr. Cir. 940, 41 pp.

Range, symptoms, cause, incidence as related to soils, and ways of reducing losses are summarized for this important disease.

CAMPBELL, W. A., and HEPTING, G. H.
Fomes annosus on slash pine. Plant Dis. Rptr. 38(3): 217.

Two examples of injury to slash pine by Fomes annosus are cited to show that the fungus can actively attack this widely planted pine.

CLAPPER, R. B.
Stimulation of pine oleoresin flow by fungus inoculation. Econ. Botany 8(3): 269-284.

Investigations on the use of the pitch canker Fusarium to stimulate oleoresin flow and pitch soaking in turpentine pines are described.

CLEMENTS, R. W.
How to install spiral gutters with double-headed nails. Florida Grower and Rancher LXII(4): 1278.

Each step in the procedure is illustrated with photographs.

CLEMENTS, R. W.
Spray your acid in the right place. AT-FA Jour. 16(8): 12, 16.

One of the most important phases of good treatment in commercial operations is--where the laborer places the acid. Careless treating habits can reduce gum yields.

CLEMENTS, R. W.

Nail that extra gum profit. Naval Stores Rev. 64(5): 14. Also in AT-FA Jour. 16(11): 13.

In pilot plant tests, longleaf pines with tins nailed on produced 74.4 barrels more gum per crop over a 2-year period than similar timber with tins inserted in broadaxe incisions.

CLEMENTS, R. W., and GEISEY, J. T.

New tool for raising tins installed with double-headed nails. Naval Stores Rev. 64(6): 9. Also in AT-FA Jour. 16(12): 11.

A new raising tool which greatly simplifies the job of raising tins installed with double-headed nails permits one man to do the entire job of raising at the tree.

COOPER, R. W., and OLSON, D. F.

A successful slash pine plantation on a longleaf site. AT-FA Jour. 17(1): 15.

A 22-year plantation under management on a dry Florida site produced 1.4 cords pulpwood per acre annually.

COPELAND, O. L., Jr.

Estimating the littleleaf hazard in South Carolina Piedmont shortleaf pine stands based on site index. Southeast. Forest Expt. Sta. Research Note 57.

Data are presented for estimating the littleleaf expectancy in established shortleaf pine stands in the South Carolina Piedmont.

CRUIKSHANK, J. W.

Site index of the major pine forest types in the Southeast. Southeast. Forest Expt. Sta. Research Note 50.

The proportion of each major forest type area in each site index class.

CRUIKSHANK, J. W.

1953 pulpwood production in the South. Southeast. Forest Expt. Sta. Forest Survey Release 43, 34 pp.

The number of cords of pine, hardwood, and chestnut pulpwood produced in each county and state of the South.

CRUIKSHANK, J. W.

Southern pulpwood production increased in 1953. Southeast. Forest Expt. Sta. Research Note 60.

The number of cords of pine, hardwood, and chestnut pulpwood produced in each southern state.

CRUIKSHANK, J. W., and GILL, C. E.
Virginia's woodlands. Virginia Farm Economics (138): 19-25.

A brief description of the forest area, forest land ownership, and timber products of Virginia.

DAVIDSON, R. W., and CAMPBELL, W. A.
Poria cocos, a widely distributed wood-rotting fungus. Mycologia 46(2): 234-237.

Describes the variety of tree hosts in the United States from which Poria cocos has been isolated.

DEMMON, E. L.
Forest research--past, present, and future. The Forest Farmer 13(7): 12, 27, 36.

History of forest research in North Carolina.

DEMMON, E. L.
Futures in research. The Forest Farmer 13(12): 7-9, 15, 16.

The small beginnings of forest research in the South have blossomed into a large-scale search for new methods, new markets, and even new strains of trees.

DEMMON, E. L.
Digest of panel discussion on maximum growth of pulp fiber per acre. Pulpwood Annual--1954, edited by American Pulpwood Assoc., published by Pulp and Paper magazine, N. Y., pp. 48, 50.

Discussion of quality vs. quantity in connection with pulpwood yield. Weight is a better measure of quality than volume.

DOOLITTLE, W. T.
Weevils attracted to bud-pruned white pine. Southeast. Forest Expt. Sta. Research Note 63.

Finger budding increases susceptibility of white pine leaders to weevil damage.

ENGLERTH, G. H., and SMITH, W. R.
Guide for grading southern pine logs. Southeast. Forest Expt. Sta., 7 pp.

A pocket guide defining grading defects and giving log grading procedure in handy tabular form that does not require computations.

EVANS, T. C., and GRUSCHOW, G. F.
A thinning study in flatwoods longleaf pine. Jour. Forestry 52(1): 9-10.

A 16-year record shows satisfactory volume growth over a wide range of stand density. Annual diameter growth of more than 0.1 inch resulted only in residual stands of less than 65 square feet per acre.

HALLS, L. K.
The evaluation of Southern range conditions. Eleventh Annual Southern Pasture & Forage Crops Conf., pp. 35-41.

Presents a brief description and evaluation of several Coastal Plain range types and points out lesser importance of Piedmont and mountain grazing areas.

HALLS, L. K.
Low-cost range improvement pays in the Southeast. Southeast. Forest Expt. Sta. Research Note 54.

Spring broadcasting of carpetgrass and lespedeza seed on cut-over slash pine forest land, burned the previous fall, increased the annual return from grazing three-fold, from $2.10 to $6.14 per acre.

HALLS, L. K.
The approximation of cattle diet through herbage sampling. Jour. Range Mgt. 7(6): 269-270.

Develops the possibility of making direct estimates of cattle diet in the field by comparing estimates of cattle diet with nutrient analyses of herbage samples.

HALLS, L. K., and HAWLEY, N. R.
Slash pine cone production is increased by seed-tree release. Southeast. Forest Expt. Sta. Research Note 66.

Flower fertilization increased one year after release, and cone production increased the third year after release.

HALLS, L. K., and SOUTHWELL, B. L.
Consumption of minerals by cattle on southeastern coastal plain forest range. Jour. Range Mgt. 7(4): 163-165.

Salt and bone meal, recommended sources of phosphorus and calcium, must be mixed to insure adequate free-use by range cattle. Breeding cows maintained yearlong on native range will consume about 74 pounds of a 2 to 1 mixture of steamed bone meal and salt per year.

HALLS, L. K., and SUMAN, R. F.
Improved forage under southern pines. Jour. Forestry 52(11): 848-851.

Good stands of improved forage species such as Louisiana white clover, carpetgrass and Dallas grass can be established without tillage in longleaf-slash pine forests following litter removal by burning, and providing fertilizer and lime are applied to the soil. The best stands were obtained on poorly stocked areas having less than 50 square feet of tree basal area per acre.

HARRAR, E. S.
Defects in hardwood veneer logs: their frequency and importance. Southeast. Forest Expt. Sta. Paper 39, 45 pp.

Classifies and describes the type of defects found in yellow-poplar, water tupelo, red gum, and black gum veneer logs. Illustrations show defects at various depths of logs as veneer is peeled.

HAWLEY, N. R.
A 50-year partnership in forest research. AT-FA Jour. 16(9): 4-5, 9.

Foresight in private management of slash pine prepared the ground for the George Walton Experimental Forest.

HAWLEY, N. R.
Basic management steps governing a 50-year partnership in forest research. AT-FA Jour. 16(10): 6-7.

(1) Survey boundaries, (2) control fires, (3) inventory timber, (4) determine growth, (5) integrate operations, and (6) provide for regeneration.

HAWLEY, N. R.
Land surveys for 50-year partnership in forest research. AT-FA Jour. 16(11): 8-9.

42 miles of survey line rerun, blazed, painted, and corners permanently monumented for experimental forest.

HAWLEY, N. R.
Early fire protection insures a 50-year partnership in forest research. AT-FA Jour. 16(12): 4-6.

An account of a successful pioneer private enterprise in forest protection.

HAWLEY, N. R.
The basic cruise for a 50-year partnership in forest research. AT-FA Jour. 17(1): 4-7.

Description of timber cruising and inventory work on the George Walton Experimental Forest.

HAWLEY, N. R.
Growth studies for a 50-year partnership in forest research. AT-FA Jour. 17(2): 6-8.

Young, understocked sawtimber stands doubled their volume in about four years.

HAWLEY, N. R.
Marking rules for a 50-year partnership in forest research. AT-FA Jour. 17(3): 10-12.

Improvement cutting removes diseased trees, "poor risks," and other unsatisfactory growing stock.

HAWLEY, N. R.
An island of green in a sea of fire. Forest Farmer 14(2): 6, 7, 19.

A success story of the public relations problems in pioneering forest management.

HEPTING, G. H.
Gum flow and pitch soak in Virginia pine following Fusarium inoculation. Southeast. Forest Expt. Sta. Paper 40, 9 pp.

Describes gum yields and amount of pitch-soaking in Virginia pine following inoculations with the pitch canker fungus.

HOEKSTRA, P. E.
New blood for southern pines. South. Lumberman 189(2369): 182-183.

Non-indigenous species and varieties of pine are being established in Florida to furnish material for tree improvement.

HOOVER, M. D., METZ, L. J., and OLSON, D. F., Jr.
Soil sampling for pore space and percolation. Southeast. Forest Expt. Sta. Paper 42, 28 pp.

Describes methods of sampling soil for pore space and percolation at the Piedmont Research Center, including field collection, laboratory analysis, and computational methods.

KEETCH, J. J.
Instructions for using forest fire danger meter type 8. Southeast. Forest Expt. Sta. Paper 33, 7 pp.

How to use the meter used by all fire control agencies throughout Region 7.

KEETCH, J. J.
Forest fire danger meter type 8. Northeastern Logger 2(9): 16.

A brief general discussion of meter type 8.

KEETCH, J. J.
Instructions for using forest fire danger meter type 8. Fire Control Notes 15(3): 40-46.

Reprint of Station Paper No. 33.

KEETCH, J. J., and GLADSTONE, M. C.
1953 forest fires and fire danger in Connecticut, Kentucky, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia.

Thirteen separate state reports containing tables and graphs analyzing forest fires and fire danger.

KORSTIAN, C. F., MAKI, T. E., OSTROM, C. E., and SCHEER, R. L.
Desirable cutting practices for North Carolina forests. N. C. Forestry Assn., Raleigh, 22 pp.

Recommendations for the following types: Eastern white pine, mountain cove, loblolly-shortleaf pine, Virginia pine, longleaf pine, pond pine, and bottomland hardwoods of the coastal plain.

KOVNER, J. L., and EVANS, T. C.
A method for determining the minimum duration of watershed experiments. Trans. Amer. Geophys. Union 35(4): 608-612.

A simple, graphic solution is described for approximating the period required to detect significant differences between treatments on experimental watersheds.

LANGDON, O. G.
Gum yields of South Florida slash pine. Southeast. Forest Expt. Sta. Research Note 47.

Gum yields from South Florida slash pine were only 119 barrels per crop, which is considerably lower than the 200 barrels per crop average for the northern slash pine.

LANGDON, O. G.
Skilful, lifting techniques increases seedling survival. South. Lumberman 189(2369): 153-154.

Common errors are: blade too dull, set at wrong angle or depth, or drawn too fast.

LARSON, P. R.
Three-quarter-inch chipping proves best. AT-FA Jour. 16(8): 13, 16.

Gum yields were increased about 10 percent by increasing streak height from 1/2 or 5/8 inch to 3/4 inch. The necessity for chipping out of the acid-killed tissue above the face is emphasized.

LARSON, P. R.
Shoulder of face produces most gum. AT-FA Jour. 16(11): 12.

Twice as much gum was obtained from the shoulders of the face as from the center of the face. Hence, large quantities of gum will be lost if tins do not extend under the entire face.

LARSON, P. R.
Winter chipping can be profitable. AT-FA Jour. 17(2): 12. Also in Naval Stores Rev. 64(7): 19.

Chipping at triweekly intervals during the winter following either the first or second year of work was barely profitable. No decline in gum yield occurred during the regular seasons following winter chipping.

LARSON, P. R.
Labelling and storing increment cores. Jour. Forestry 52(4): 252.

Suggests using large-sized malted milk straws as individual containers for cores.

LITTLE, E. L., Jr., and DORMAN, K. W.
Slash pine (Pinus elliottii) including South Florida slash pine, nomenclature and description. Southeast. Forest Expt. Sta. Paper 36, 82 pp.

A report on botanical basis for a recent change in scientific nomenclature.

LOTTI, T.
Temporary tree marking. Jour. Forestry 52(2): 130-131.

Kaolin or marble dust for the temporary (sock) marking of trees is preferable to lime because less irritating to workers.

McCLAY, T. A.
Lumber grade yields in the loblolly-shortleaf pine type by the southern pine log grades. Southeast. Forest Expt. Sta. Paper 37, 12 pp.

Mill-scale studies show quality indices for pine logs and lumber grade recovery percentage by log size and grade.

McCLAY, T. A.
Loblolly pine topwood volumes. Southeast. Forest Expt. Sta. Research Note 61.

Top volume per tree and per M board-feet from trees of different sizes is given for various limits of utilization.

McCORMACK, J. F.
Forest statistics for North Central and North Georgia, 1953. Southeast. Forest Expt. Sta. Forest Survey Release 42, 31 pp.

Forest area, timber volume, growth, and timber-cut statistics and trends in timber volume.

McCORMACK, J. F., and CRUIKSHANK, J. W.
Forest statistics for Georgia, 1951-53. Southeast. Forest Expt. Sta. Forest Survey Release 44, 77 pp.

Forest area, timber volume, growth and timber-cut statistics, and trends in timber volume.

McGREGOR, W. H. D.
Flatwoods farm woodland improvement pays. Agr. Ext. Serv., Univ. Florida, Cir. 125, 11 pp.

Substantial improvement in growth, stocking, gum yields, and stand composition achieved in 10 years.

McGREGOR, W. H. D., COWAN, D. R., and SPURR, S. H.
Three races of scotch pine compared in southeastern Michigan, U. of Mich., Dept. Forestry, Michigan Forestry No. 5, 2 pp.

The trees from northern Europe grow more slowly but have better form than those from central Europe.

MERGEN, F.
Grafting succulent slash pine scions. Southeast. Forest Expt. Sta. Research Note 59.

The discovery that scions can be grafted in the succulent stage promises to prolong the grafting season by several months.

MERGEN, F.
Variation in 2-year-old slash pine (P. elliottii var. elliottii) seedlings. Southeast. Forest Expt. Sta. Research Note 62.

Survival of seedlings from all five geographic seed sources in Florida was high, but the growth of one from Polk County was low.

MERGEN, F.
Self-fertilization in slash pine reduces height growth. Southeast. Forest Expt. Sta. Research Note 67.

Self-pollination tends toward poor seed set, low germination, reduced vigor, deformed growth, retarded flowering, or some degree of albinism.

MERGEN, F.

Heteroplastic micrografting of slash pine. Southeast. Forest Expt. Sta. Paper 47, 17 pp.

A project in grafting 1- to 6-month-old slash pine seedlings onto other coniferous species such as white spruce, white pine, ponderosa pine, and others.

MERGEN, F.

Improving the early growth of longleaf pine. Naval Stores Rev. 64(3): 12, 13, 21. Also in Forest Farmer 13(11): 8, 9, 16, 17.

Some 261 slash-longleaf pine hybrids have been produced for possible use in reforestation of dry sites.

MERGEN, F.

Vegetative propagation techniques for genetics studies of slash pine (Pinus elliottii, Engelm.). American Soc. Plant Physiologists. Program for the 29th Annual Meeting, pp. 6-7.

Review of technics covered in more detail in other publications.

MERGEN, F.

Mechanical aspects of wind-breakage and windfirmness. Jour. Forestry 52(2): 119-125.

Crown thinning and early improvement cuttings increase the exposure of young stands to wind pressure; in response the trees become more windfirm--less susceptible to storm damage.

MERGEN, F.

Inheritance of oleoresin yield in slash pine. AT-FA Jour. 17(2): 16-18. Also in Naval Stores Rev. 64(9): 8, 9, 20.

A test of the progeny from parent trees selected for high gum production showed that gum yielding ability is inherited.

MERGEN, F., and HOEKSTRA, P. E.

Germination differences in slash pine from various sources. South. Lumberman 189(2364): 62, 64, 66.

Real differences are indicated in seed characteristics from collections in different locations.

MERGEN, F., and POMEROY, K. B.

Tree improvement research at Lake City, Fla. Research Center, a project analysis. Southeast. Forest Expt. Sta. Paper 45, 59 pp.

Superior attributes sought are rapid growth, disease resistance, better stem form, and improved grain or density of wood.

MERGEN, F., and POMEROY, K. B.
Suggestions for better slash pine seed. Forest Farmer 13(5): 6-7, 15.

Directions for selection and reservation of trees capable of producing superior seeds in quantity.

MERGEN, F., and ROSSOLL, H.
How to root and graft slash pine. Southeast. Forest Expt. Sta. Paper 46, 22 pp.

A graphic exposition of new technics for asexual propagation of pines useful as breeding stock (45 drawings).

MERKEL, E. P.
Southern pine beetle conditions in western North Carolina and eastern Tennessee. Southeast. Forest Expt. Sta. Forest Pest Survey Report 1.

Survey shows 46, 000 trees on 155 acres are currently infested.

MERKEL, E. P.
Southern pine beetle conditions on the Cherokee National Forest and adjoining private lands. Southeast. Forest Expt. Sta. Forest Pest Survey Report 2.

Survey shows 7, 100 trees are currently infested with beetles and in need of treatment.

MERKEL, E. P.
The pine needle miner on the North Carolina National Forests. Southeast. Forest Expt. Sta. Forest Pest Survey Report 3.

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The role of genetics in southern forest management. Part I, Forest Farmer 14(1): 4-6, 14-15. Part II, Forest Farmer 14(2): 8, 9, 14-19. Part III, Forest Farmer 14(3): 8, 9, 14, 15.

I. Environment is the most important factor in tree development only within definite genetic limits.
II. Seed collection for forest nurseries must be from the most favorable geographic origin.
III. In reserving seed trees select superior individuals in so far as possible.